Scientific Agriculture

La Revue Agronomique Canadienne

VOL. VI. OTTAWA, ONT., SEPTEMBER, 1925. No. 1

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Published Monthly by the Canadian Society of Technical Agriculturists.

Forms close on the 23rd day of each month; all copy for advertisements, and changes of advertisements, should be received ten days before the date of issue.

All correspondence should be addressed "Scientific Agriculture, P. O. Box 625, Ottawa, Ont."

Cheques, money orders, etc., must be made payable to the order of the Canadian Society of Technical Agriculturists (C.S.T.A.)

Advertising rates on application.

Subscription price $2.00 *yearly to Canada and the United States; other countries* $2.50.

The Origin of False Wild Oats*

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Oats which in many respects appear to be intermediate in character between the common cultivated oat, *Avena sativa*, L., and the wild oat, *A. fatua*, L., are frequently found in both commercial varieties and pure-line strains of *A. sativa*. In Canada and the United States these forms are commonly known as false wild oats or fatuoids, and in Europe as fatuoids, *Fatuoidmutationen*, *Fatuoiderna*, *Intermediarformen*, etc. Their origin has been a matter of dispute, sometimes acrimonious, for at least forty years, and although considerable work has been done on the problem there is still much difference of opinion regarding not only their origin, but also their agricultural significance. In Canada at present they are generally classified as "harmful weeds" and they are particularly troublesome to growers of high grade seed oats.

Apart from the direct agricultural importance of the problem, the origin of false wild oats is a matter of great interest in its general bearing on the question of variation, as the mechanism which produces these forms is probably concerned in the production of at least some of the aberrant forms found in other species. The "speltoid mutations" of wheat, in particular, are very closely analgous to fatuoid oats, and an explanation of the origin of the one would probably apply equally well to the other. The origin of certain dwarf forms in both wheat and oats also appears to be very closely connected with the occurrence of speltoids or fatuoids.

In the course of a genetic and cytological investigation on the origin of false wild oats, which was begun in this department during the winter of 1923-24, and is now proceeding with the assistance of the Research Council of Canada, the literature of the subject has been extensively reviewed. Several conclusions of importance to agriculture have emerged from this review, and it is therefore proposed to publish this part of the work now. The conclusions from the genetic and cytological investigation will follow as soon as the work is completed. A brief outline of some of the cytological observations was recently recorded. (Nature 115; 677-678, May 9, 1925).

I.—Direct Studies on the Origin of False Wild Oats

Haussknecht in 1884, quoted by Zade (1918), pointed out that intermediate forms which appear to form a continuous chain between *Avena sativa* and *A. fatua* occur in fields of cultivated oats. These forms he described as *Avena fatua* var. *transiens*. He found that they did not reproduce true to type but he was not very certain regarding the meaning of the segregation observed. He observed no diminution of fertility, and in accordance with the general belief of the time he therefore argued that they could not be the product of a cross between two distinct species. He reported that in continuous cultures the hairy base disappears and the seed comes to resemble the ordinary cultivated oat so closely that it can no longer be recognized as different.

Max Fischer in 1900, also reported by Zade (1918), contended that winter oats in particular were inclined to revert to wild oats, and he therefore recommended caution in growing them. He admitted that the intermediate oats which he found might be the products of a cross, but maintained that it was more likely that they were "throw-backs."

Howes (1908) collected oat grains showing "wild tendencies", i.e. prominent basal articulations or "sucker mouths" and heavy twisted awns, from four standard cultivated varieties—Black Mesdag, Swedish Select, Early Victor, and Early Ripe. The Early Ripe variety is considered to be derived from *A. sterilis*; the others are representatives of *A. sativa*. The plants grown from these selected grains were found to be similar to the parent varieties in growth-habit and in every way except that the seeds they produced again showed the same "wild tendencies". Experiments conducted for three years showed that the strains with "wild tendencies", the normal parental varieties from

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* Report on an investigation being carried out in the Division of Genetics and Plant Breeding, Department of Field Husbandry, University of Alberta, Edmonton, Canada.

which these were selected, and several varieties of *A. fatua* all reproduced true to type. During this period there was therefore no evidence of "reversion" which was at that time one of the most commonly accepted explanations of the origin of false wild oats. It was noted however, that environmental conditions cause a certain amount of variability in the development of the "wild tendencies".

An important finding recorded by Howes was that none of these false wild oats had the property of delayed germination which is one of the characters of *A. fatua* making the latter a serious weed menace.

Thellung in 1911, according to Zade (1918), also found intermediate forms of oats and supported Haussknecht's view that they were spontaneously developed variations.

Criddle (1912) published excellent illustrations and descriptions of different types of wild oats and false wild oats which he had collected. He also reported the results of a breeding experiment with some seeds of Banner oats showing "wild tendencies," which Mr. A. Cooper of Treesbank, Manitoba, had collected in a field of that variety which was free from wild oats. Of these he says:

"The first year these were grown about two per cent developed into fully formed False Wild Oats, while a majority of the others remained as before. A certain number, however, developed stronger awns while others became entirely awnless. The more developed oats were again sown in 1911 and produced about 20 per cent of False Wild Oats, some 40 per cent of the long awned kinds, and the remainder either with no awns or with the usual weak ones generally found on the primary oat on the upper grains of the head. Some of the original seed was also sown and showed less than one per cent of False Wild Oats, but produced instead a dwarf type not above six inches in height, which though developing sufficiently to reveal the usual long awns of False Wild Oats failed to produce germinable seeds. The proportion of plants of this kind amounted to nearly one per cent."

Criddle pointed out that false wild oats do not have delayed germination, and for this reason alone they are much less noxious as weeds than wild oats. He drew no conclusions concerning their origin, but stated that since they seem to be no more numerous in oats grown in contact with wild oats than in oats kept free from wild oats, it is hardly likely that they arise as the result of crosses between the two species.

The editor of Criddle's bulletin, G. H. Clark, states that tests at the Dominion Seed Laboratory, Ottawa, showed false wild oats to have a higher percentage of hull than the normal grains of the variety in which they develop. Banner type false wild oats tested 34.6 per cent hull, and those of the Storm King type 47.1 per cent, while the averages for the normal grains of these varieties were 28.5 per cent and 32 per cent hull respectively. In false wild oats of the Storm King type he reported that 8.3 per cent of the grains were double, and in nearly all cases the primary grain was either entirely kernel-less, or the kernel was very small. He noted that E. A. Howes in 1908 had determined conclusively that false wild oats do not have the property of delayed germination.

Zade (1918) is the strongest exponent of the theory that false wild oats arise by natural crossing between *A. sativa* and *A. fatua.* He pointed out that in samples of threshed oats one often finds grains showing characters intermediate between wild and cultivated oats. These, he says, may be brown, gray, or yellowish. The light-coloured ones are less easily recognized if occurring in light-coloured varieties. The dark ones can be readily distinguished from black cultivated varieties by the fact that the primary grains usually (but not always) bear a large awn. Furthermore, he says, they have a tuft of hair at the base which sometimes extends thinly over the back of the glume. The remnant of a basal ring is also found on these grains. In short, he says, the principal points of difference between *A. fatua* and *A. sativa* are found in these intermediate forms, but in a reduced condition. In other respects the grains incline more towards the cultivated than to the wild oats. Zade states that he has seeded a quantity of these intermediate kernels and followed their offspring to the fourth generation. From the original intermediate seeds he found three types segregating in a 1:2:1 ratio. His description of these three types is not at all clear, but it may be summarized somewhat as follows:

TYPE I.—(*Sativa* type). They resemble the original cultivated variety in which the intermediate forms were found.

TYPE II.(*Fatua* type). They resemble wild oats, but are longer, more thick-bodied, and apart from the basal ring and the heavy awns they remind one of the ordinary cultivated oats.

TYPE III. (Intermediate type). The grains and the panicle-shape of these plants resemble the original variety, but it is glabrous, and this Intermediate type is somewhat pubescent.

Zade points out that the extraordinary thing about these intermediate forms is that they segregate to give only three different types, each of which is sharply separated from the others. A crossing of the probable parents, *A. sativa* and *A. fatua*, he says, would have given a variegated mixture of forms.

In the F_2 he found the intermediate forms giving rise to the same three forms in the same 1:2:1 ratio. On the other hand, the "*sativa* and *fatua* types with a few exceptions remained constant." In F_3 the intermediates again showed the same segregation, and the *sativa* and *fatua* types "were still more constant." In F_4 the latter "were again constant but not quite free from segregation." (1)

By the examination of large samples of threshed oats Zade found that the intermediate type seeds are always accompanied by wild oats, and that there is a positive correlation between the number of each. He concludes, for the following reasons, that the intermediate forms are the result of a cross between *A. sativa* and *A. fatua*.

1. The segregation is a simple Mendelian one.

2. There is positive correlation between the number of intermediate forms and the number of wild oats found in a sample of seed.

3. The intermediate forms occur frequently, whereas, he says, mutations appear only rarely, never numerously.

Having decided then that they are hybrids, Zade argues that the simple monohybrid segregation of the intermediate forms must indicate that the cross from which they originated took place many years previously. The generations described above he would therefore call, not F_1, F_2, F_3 and F_4, but rather Fx_1, Fx_2, etc.

Furthermore, Zade found some intermediate forms which gave a polyhybrid segregation, but unfortunately most of the F_2 plants were destroyed by worms.

He remarks that the intermediate forms described by Haussknecht and Fischer were evidently similar to his own. Haussknecht's remark concerning the lack of diminution of fertility, he points out is quite irrelevant. Fischer's "caution" concerning winter oats he dismisses as out of the question.

Zade next attacks the conclusions reached by Nilsson-Ehle in his 1914 paper (considered later in this review). He contradicts the latter's statement that wild oats do not occur in the vicinity of Svalöf. Further, he points out that some of Nilsson-Ehle's varieties in which intermediate forms were found, were themselves produced by crossing, and that it is difficult to be sure when one has obtained a pure-line after crossing. He holds that Nilsson-Ehle's so-called "pure lines" have not been proved to be real pure lines in Johannsen's sense of the term.

Finally, he quotes Tschermak's opinion that the greater frequency of intermediate forms which Fischer found in winter oats is due to the fact that natural crossing can take place more easily during the cooler seasons. In reply to an enquiry addressed to him concerning his present opinion of the origin of false wild oats, Professor Zade stated, in a letter dated March 4, 1925, that he was carrying out a long series of experiments with these "Intermediarformen" and that his results would not be available for publication for several years. However, he reaffirmed his opinion that the segregation is due to a crossing that has taken place some considerable time previously—it is a so-called "Spätspaltung." Furthermore, he points out that the segregation is not by any means always a monohybrid one.

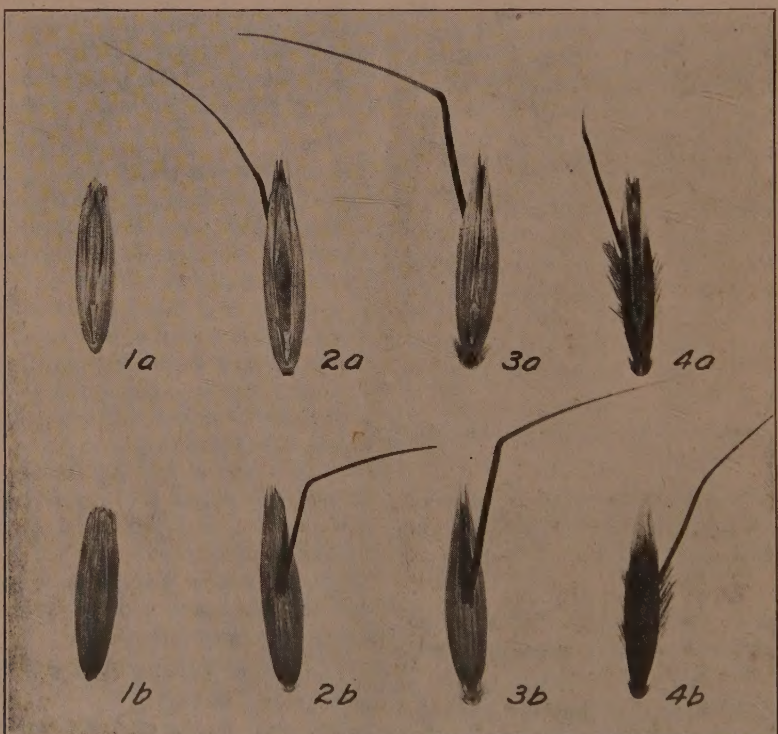
Tschermak (1914) reported that "serial segregation" occurred in a cross between *A. sativa* and *A. fatua*. No splitting up of characters was obtained, and pure forms of the parent species should, therefore, segregate out. The results of the segregation in F_2 was a predominant number of intermediate forms, a small number of the wild oat type

(1) Quotations translated from the German.

breeding true, and a small number of the cultivated type of which some bred true and some continued to segregate. Some of the intermediate forms were constant. He supported Zade's contention that the wild-type oats found in cultivated varieties are due to natural crossing, and opposed Nilsson-Ehle's theory that they are mutations.

Tschermak (1918) later reported more fully on the hybrids between cultivated and wild oats. He found a very close linkage between the two characters of the wild form "tendency for the spikelets to detach themselves from the rachis at time of ripening" and "complete development of awns." On the other hand he found incompatibility of coexistence between the character "hairiness of the glumes," peculiar to wild forms, and the character "yellow glumes," peculiar to cultivated forms. There was equal incompatibility of coexistence between the character "brown glumes" peculiar to wild forms, and the character "glabrous glumes" peculiar to cultivated forms. The F_1 was intermediate with the character "spikelets adhering" generally predominating. From the compatibilities and incompatibilities it follows that only three main types could segregate out. In F_2 these three types, wild form, intermediate form, and cultivated form apeared in the ratio 4:9:3.

In F_3 the wild forms were transmitted without change. Of the nine intermediate individuals four segregated to give the same 4:9:3 ratio. Of the three cultivated forms one remained constant, and the other two segregated to give cultivated forms and wild forms in the ratio 3:1. Two hypotheses are suggested by Tschermak to explain the behaviour in F_3. Briefly, the first is that the presence or absence of two factors is involved. The second is that in the original wild form there are three closely linked factors, and that in the original cultivated form these are separated.

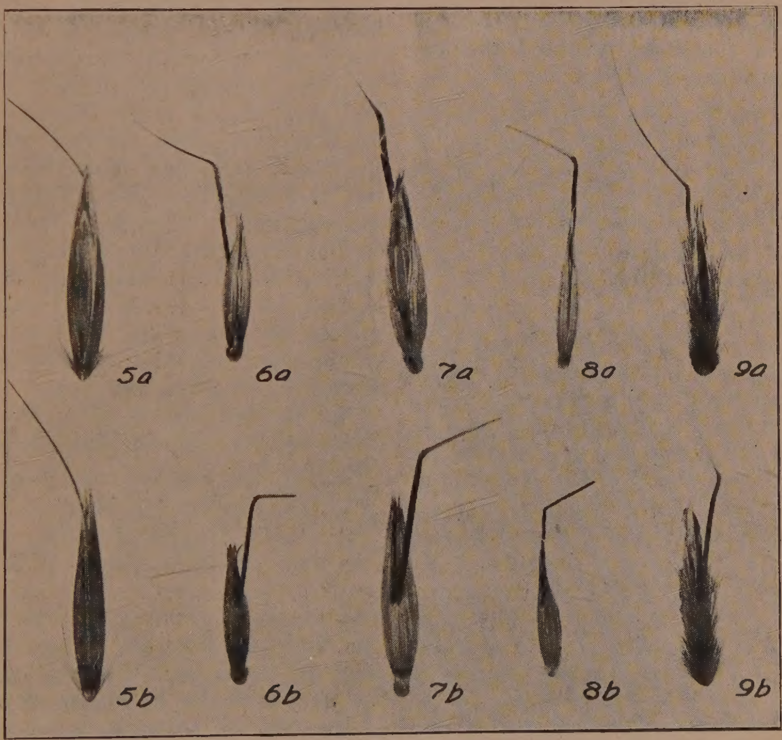


1a & b: Ventral and dorsal views respectively of primary grain of normal Banner oats.
2a & b: Heterozygous false wild oats, Banner type.
3a & b: Homozygous false wild oats, Banner type.
4a & b: Medium hairy, black wild oats (*Avena fatua*).

Tschermak's conclusions are that these phenomena of association and dissociation of characters tend to show that the appearance in cultivated oats of individuals having characters of the wild form may be due to bud mutation. It would be a case of "associative atavism" by which the three separated factors mentioned would revert partly or wholly to the closely linked condition typical of the wild form.

Nilsson-Ehle (1921) has carried out a long series of breeding experiments with these intermediate forms which he now calls "*Fatuoid mutationen*" since he believes their origin to be due to a loss mutation. He points out that they are by no means identical with *A. fatua*, but that they have certain characters in common with it, viz., the awning, the hairiness of the callus and rachis, and the basal-ring articulation. In all other respects they are like the cultivated variety in which they arise and therefore they differ from it by one definite character complex. He argues that the fatuoid complex originates through mutation in one of the sex cells, either male or female, and that by union with a normal gamete heterozygous fatuoids originate. These segregate to give normal cultivated oats, new heterozygous fatuoids, and fatuoids in the ordinary Mendelian ratio of 1:2:1. The heterozygous fatuoids have the characters of the fatuoids in a very much reduced form.

From Surface's (1916) results with the cross, *A. fatua* x *A. sativa* and from his own observations of the segregation of the heterozygous fatuoids, Nilsson-Ehle argues that this character-complex does not result from the action of a single inheritance unit, but that it results from a complex of coupled inheritance units. He concludes, however, that the coupling in the fatuoids must be very strong, if not indeed absolute, for up-to-date (1921) he had not been able to substantiate any dissolution of the complex, al-



5a & b: Ventral and dorsal views respectively of primary grain of Red Rustproof oats. (Derived from *Avena sterilis*).
6a & b: Homozygous false wild oats, Old Island Black type.
7a & b: Homozygous false wild oats, Storm King type.
8a & b: White wild oats (*Avena fatua*).
9a & b: Hairy black wild oats (*Avena fatua*).

though a large number of segregating plants had been studied. Some variation in the degree of awning had been found by one of his workers, Th. Gante, among the heterozygotes, but investigation of these did not upset the above conclusion. Gante's results will be considered later.

In 1911 Nilsson-Ehle stated that continued researches had thoroughly confirmed a simple Mendelian ratio for the segregating heterozygous fatuoids. The statement is modified in his 1921 paper. In some strains the simple 1:2:1 ratio seems to be present, but in others there is a marked deficiency of the fatuoids. This deficiency is explained, however, by the observation that the fatuoids are always weaker than the normal oat plants, and they therefore suffer more under unfavorable environmental conditions. Nilsson-Ehle had not determined whether or not the weakness extended to the gametes also, but by analogy with the corresponding speltoid heterozygotes of wheat he argued that it probably did. If such was the case, he anticipated that the normal pollen would be favoured over the fatuoid pollen in fertilization.

In view of the fact that the fatuoids always show all the characters of the particular variety in which they arise, with the single exception of the coupled character-complex mentioned, Nilsson-Ehle concludes that Zade's hypothesis of their origin by natural crossing is completely invalid.

An attempt made by Heribert-Nilsson to explain the origin of the fatuoid and other "recessive mutations" through segregation of concealed heterozygotes (apparently homozygotes) and thus not through real mutation, is set forth and countered by Nilsson-Ehle (1921). He states that Heribert-Nilsson perceived clearly that if the "mutating" strain is really heterozygous then one has to find an explanation for its general constancy. The strain cannot be a monohybrid (monomer) with respect to the changing character, for if it were it would give rise to fatuoids directly—which, he says, it never does, as the heterozygous fatuoids are always formed first. The distinction between the normal types and the fatuoid must therefore be presumed to consist in two or more complex inheritance units. This, however, would not fit the facts, because segregations of 15:1, or 63:1, etc., would result in such a case and these ratios are never found. One has therefore to adopt the hypothesis of linkage. By doing this Heribert-Nilsson built up an ingenious theory, which Nilsson-Ehle says is of great interest and must be taken into consideration, even though it does not give a satisfactory explanation.

According to Heribert-Nilsson the heterozygous fatuoid has arisen in the simplest cases from the union $\overline{\text{Ab}}$ x $\overline{\text{aB}}$. The factors A and B are "homomers", (duplicate factors) each producing the normal type, but if both fail (a b) gives rise to the recessive "mutant". In consequence of very close linkage between a and B, and A and b respectively, the gamete combination A B and a b would be formed only very rarely. The unions Ab x ab and aB x ab give rise to the heterozygous fatuoids — the very close linkage accounting for their rare occurrence. They would then segregate to give normal types AA bb (or aa BB), heterozygous fatuoids Aabb (or aaBb), and fatuoids (aa bb) in the simple 1:2:1 ratio. The theory demands that the segregating concealed heterozygotes, (apparently homozygotes) $\overline{\text{Ab}}$ x $\overline{\text{aB}}$ shall be similar phenotypically to the real homozygotes Ab x Ab and aB x aB. These three types together form the supposed pure-lines, the constancy of which, on account of the very close linkage, is disturbed only very occasionally. The fact that homozygous fatuoids (ab x ab) are not generally found arising directly is taken into account by the hypothesis of very close linkage, for the closer the linkage the more seldom will the fatuoid be formed in comparison with the heterozygous fatuoid.

So far the theory is quite clear, says Nilsson-Ehle. The difficulty lies, he says, in the fact that the concealed heterozygotes $\overline{\text{Ab}}$ x $\overline{\text{aB}}$ must regularly give rise to real homozygotes Ab x Ab and aB x aB in half of their progeny. These, according to the theory, cannot change further. Therefore, in selecting plants from the progeny of the concealed heterozygote one has a 1:1 chance of obtaining a homozygote. Since all the pure lines of oats at Svalöf had been subject to a pedigree selection for from 2-6 years before the occurrence of heterozygous fatuoids in them was reported, it is extremely improbable that they were not homozygous. Nilsson-Ehle therefore claims that this theory cannot be applicable to the fatuoid mutations he has reported. He points out, however, that fatuoid-

like forms may arise by natural crossing between *A. sativa* and *A. fatua.* There are indeed, he says, many cases known whereby similar types arise by crossing and by mutation. But he states that the fatuoids which he found in Sweden, segregating from heterozygous fatuoids, are undoubtedly mutations.

By "mutation" he implies nothing more than a spontaneous hereditary modification which is not due to crossing and segregation. Through what change of hereditary substance the mutation arises he leaves as an open question.

Gante (1921) has studied a peculiarity of awning in heterozygous fatuoids from Nilsson-Ehle's material. The seeds of these typically have awns somewhat stronger and more decidedly bent than those of the normal cultivated oats. But these awns are on the lower grains only. The grains are also more hairy at the base or on the rachis than the normal oats, but again only on the lower grains. They have no pronounced basal articulation, or ring-pad as he calls it. When working with some of these heterozygous fatuoids Gante was surprised to find some plants which had awns on all the grains. He also found plants which had occasionally three grains to the spikelet, and in these cases the two lower grains were awned. The ring-pad was absent in all cases, but the hairiness was more pronounced in the grains of the spikelets having two awns than on the other grains of the same panicle.

The seeds from the one-awned and the two-awned spikelets were planted separately in 1920. Their segregation was similar, thus showing that they were not bud mutations. This peculiarity is believed to be due to a stronger tendency to awning in some strains than in others. The effect of environment had not been studied at the time of writing (1921), but an investigation of this was planned.

Åkerman (1921) reported the occurrence of "*Fatuoiderna*" in pure lines of oats and also in mixed populations. Heterozygous fatuoids were also reported as being found occasionally. These segregated in the 1:2:1 ratio. Except for the strong bent awn, the basal-ring articulation, and the tuft of stiff hairs at the base of the seed, the fatuoids were identical with the variety in which they were found. Because of Nilsson-Ehle's conclusions, and because the hybridization experiments of Tschermak and Surface showed the segregation to be very complicated in the case of true crosses between *A. sativa* and *A. fatua,* Akerman concludes that the theory of a hybrid origin for these fatuoids is excluded. Therefore, he says, the fatuoid form must be regarded as a true mutant.

Marquand (1922) reported the occurrence of homozygous false wild oats in six different varieties of oats at the Plant Breeding Station at Aberystwyth, Wales. In all cases these were identical with the parent varieties except for the character of the awns, basal articulation, and hairiness. The varieties differed widely in many characters including colour and panicle type—two of them belonging to the subspecies *orientalis*.

In only one case has a fatuoid plant arisen in Marquand's pot cultures. This was of the Victory variety, and "it was the only aberrant plant from a *normal* panicle bearing 35 spikelets, of which all the grain was grown separately for experimental purposes in 1921. In this the *fully* developed form was produced at once." The next generation had not been raised at the time of publication, so that it was impossible to say whether segregation would take place or not, but since the plant agreed exactly in type of grain with the homozygous fatuoids of other varieties described, it appeared unlikely that it would segregate.

Marquand states that it is now quite well established that fatuoids have no direct connection with *A. fatua.* Concerning the latter he says: "In the F_1 of the cross, (*A. fatua* x *A. sativa*) the solidified base of *Avena sativa* is dominant, but the plant partakes of many of the vegetative characters of its wild parent, *A. fatua.* In F_2 a wide segregation occurs and homozygotes with the character of *A. sativa* can be isolated. It is probable that these mutations and hybrids, as well as the actual increase of *Avena fatua* as a weed, were responsible for the popular idea, mentioned in some of the early Floras, that under bad cultivation *Avena sativa* was capable of reverting to the wild oat, *Avena fatua.*"

It may be noted that in his classification of the genus *Avena,* Marquand refers to *A. sativa* as "an artificial species comprising the derivatives of *A. fatua.*"

Garber (1922) found false wild oats in a number of pure lines of oats growing on the

University Farm at St. Paul, Minnesota. Those occurring in the three varieties Victory, Garton 784, and Aurora were studied carefully, and the results discussed.

Both homozygous and heterozygous false wild oats were found in Victory. These types were sharply differentiated from each other and from the normal Victory. Seed of individual plants of each of the three categories was sown separately in individual plant-rows. Five such rows of normal Victory contained a total of 92 plants, all of which were like the parent. Five similar rows of the homozygous false wild oats contained 88 plants, likewise all true to the homozygous parental type. Fifteen individual plant-rows of heterozygous false wild Victory contained 54 plants of the Victory type, 163 of the heterozygous form, and 80 of the homozygous. This ratio, it is pointed out, does not agree very closely with the expected 1:2:1 ratio.

The plants of the variety Garton 784, and the heterozygous and homozygous false wild oats found in it, could be distinguished from one another clearly, on the basis of awn development, pubescence and articulation. On the other hand they all had black seeds and side panicles, and were non-liguled forms. The Garton 784, and the homozygous false wild oats again bred true. The sixteen heterozygous plants produced 81 of the Garton 784 type, 122 heterozygotes, and 55 homozygous false wild. Here again the ratio did not agree very well with the expected. But when the heterozygous plants of the Victory and the Garton 784 varieties are considered together the ratio approaches very closely to the expected 1:2:1.

Aurora is a short, plump, yellow-seeded, early maturing variety. Two homozygous false wild plants were found in this variety, and they bred true. A careful search failed to reveal any apparently heterozygous plants. However, one of the 19 plants selected as pure Aurora gave 6 homozygous false wild Aurora, and 13 which were apparently true Aurora. Garber points out that the phenotypes of Aurora and heterozygous false wild Aurora may be very similar.

Crosses were made by Garber between different varieties of *A. fatua* and *A. sativa* or *A. sativa orientalis* for comparison with false wild oats.

The F_2 of a cross between a brown, hairy wild oat and Victory showed segregation of panicle type; size, shape, and colour of seed; and amount of hair on the lemma as well as around the seed articulation. The segregation with respect to articulation was approximately one *fatua* to three non-*fatua* types. Another cross Victory x a yellow wild oat showed essentially similar segregation.

Crosses were also made between the same wild parents and Garton 748, which is a non-liguled, side-panicled oat similar to Garton 784 except in awn development and length of rachilla on the lower seed. The F_2 of these crosses exhibited segregation similar to that of the Victory x *A. fatua* crosses in the points noted above. In these Garton 748 x *A. fatua* crosses, however, the one parent is liguled and the other non-liguled. In the total of 520 F_2 plants only 10 were without ligules. Garber concludes that apparently three independently transmitted factors are involved in ligule inheritance in this case.

In a Victory x Garton 784 cross Garber found the segregation in F_2 in respect to the ligule to be 789 with ligules to 38 without ligules. The F_3 segregation confirmed a two-factor difference for ligule inheritance.

Garber concludes that in the progeny of heterozygous false wild oats a single factor difference is involved, whereas, in the *fatua* x *sativa* crosses there are undoubtedly several factor differences involved. He points out that to accept Zade's hypothesis of natural-crossing as the origin of false wild oats, one must account for the selective elimination of all phenotypes except the three types: cultivated, intermediate, and false-wild oats, or else assume that the progeny of a natural cross do not segregate as do those of an artificial cross. It is more probable, Garber considers, that false wild oats originate by mutation, as claimed by Nilsson-Ehle. Tschermak's and Zade's suggestion that false wild oats may originate by crossing between cultivated varieties is shown by Garber to be open to the same objections as the theory that they arise from crosses between *A. fatua* and *A. sativa.*

Garber points out, however, that natural crossing occasionally occurs in oats. It is possible, he says, that once a mutation has produced false wild oats, their further dissemination may be facilitated by natural

crossing. There is also the possibility he concludes, of confusing segregates of *fatua* x *sativa* natural crosses with real false wild oats.

Garber and Quisenberry (1923) conducted comparative germination tests of *A. sativa, A. sativa orientalis*, two varieties of *A. fatua*, and second generation seed of four reciprocal crosses between these species. They found the character "delayed germination", characteristic of wild oats, to behave as a recessive in the *fatua* x *sativa* crosses. It was apparently linked with the fatua-like seed articulation, but the linkage was not close. Delayed germination was not found in seed from heterozygous false wild, or homozygous false wild, or sativa plants.

This is direct evidence against the hypothesis that natural crossing is the cause of the origin of false wild oats. They conclude that mutation is the more reasonable explanation.

Newman (1912, 1923) has reviewed the findings of Nilsson-Ehle and Garber, and has discussed the opinions of some other workers on this problem. His papers have proved very helpful in this investigation, but they will not be reviewed here as Nilsson-Ehle's and Garber's original works have been considered separately.

II.—Indirect Evidence of the Origin of False Wild Oats

A number of studies in oat breeding which have a direct or indirect bearing on the problem of the origin of false wild oats may be mentioned briefly.

Surface (1916) made a study of the inheritance of glume characters in the cross *A. fatua* x *A. sativa* var. Kherson. He found the F_1 plants to be generally intermediate between the two parents. The grain was brown in colour but distinctly lighter than the wild parent. Medium heavy awns were present on the lower grains of some spikelets, but none were found on any of the upper grains. The lower grain was pubescent on the back, but the upper grain was entirely glabrous. There was a fairly large tuft of hair at the sides of the base of the lower grain, but none on the upper grain. The base of the lower grain was intermediate in character, but more closely resembled the cultivated parent. The base of the upper grain was like the cultivated parent.

The data from 465 F_2 plants showed that "the wild parents carry genes for grey and probably for yellow color in addition to the black. These three colours segregated independently of each other". The cultivated-type base of the grain is dominant and segregated independently of the colour genes.

Seven pairs of characters were found to be completely correlated with the character of the base. Those associated with the wild base were: "(1) heavy awn on the lower grain, (2) awns on the upper grain, (3) wild base on the upper grain, (4) pubescence on the pedicel on the lower, and (5) on the upper grain, (6) pubescence on all sides of the base of the lower grain and (7) pubescence on the base of the upper grain." Surface stated that there was no evidence in this cross to indicate whether these characters were due to the action of a single pair of genes, or to several pairs completely linked, but that evidence from other crosses indicated the existence of separate genes for some of them. The gene for pubescence on the back of the lower grain was found to be partially linked with the black colour factor.

The gene for pubescence on the back of the upper grain segregated "independently of the colour factor except that in the absence of the gene for pubescence on the lower grain the gene for pubescence on the upper is unable to act."

Surface and Pearl (1915 p. 5) reported that they had never observed a single natural cross in oats, although for several years they had planted black, yellow, and white oats with open and side heads in adjacent rows only one foot apart. They quoted Rimpau who during six years' observations of 19 different varieties of oats observed only five spontaneous crosses. They concluded that practically every oat plant will be homozygous for all its characters.

Surface and Zinn (1916 p. 142) expressed the opinion that spontaneous germinal changes occur in oats, though with relatively rare frequencies.

Gaines (1917, pp. 47-60) described the F_2 of a large number of crosses between widely differing varieties of oats. In ten different crosses he found dark color to be pretty uniformly dominant over light colour. An average of all the counts made gave almost an exact 3:1 ratio.

Very puzzling results were obtained by Gaines in the F_2 of crosses between spreading panicle type oats. He was unable to explain some of these. The hypothesis of natural crossing was rejected because five years of experiments with over 100 selections of oats grown in rows side by side had convinced him that natural crossing of oats seldom, if ever occurs.

Love and Craig (1918) made crosses of *A. fatua* x *A. sativa*, var. Sixty Day. They found that the yellow colour of the latter variety inhibits the production of awns,of hairiness on the grain, and of the fatua-like base. There are two factors for pubescence, they report. The one is linked with black, and the other is independent of any colour factor.

Fraser (1919) found some spikelets with strong and intermediate awns in certain plants of the F_2 and F_3 of a cross between a weak-awned oat and an awnless variety. A number of possible explanations are discussed. Natural crossing with *A. fatua* or its hybrids which grew near the F_2 plants was considered unlikely to be the cause since the other characters of *A. fatua* were not shown except in one case and then only with respect to colour and dorsal hairs. Fraser stated further that no clear case of natural crossing in oats had ever been observed at the Cornell Station.

The hypothesis of bud mutation was rejected because none of the abnormal grains produced plants bearing all abnormal grains. "The F_2 plants bred true only for the tendency to produce some strong-awned and intermediate spikelets."

Reversion was considered by Fraser to be the most probable explanation, since one of the parental varieties is considered to be a derivative of A. sterilis. "It seems quite possible," he says, "that the process is one of reversion, due to a modification of certain inhibitory factors so that they do not completely prevent the appearance of strong awns." This explanation, however, was submitted only as a conjecture.

Stanton and Coffman (1924) made a systematic study of natural crossing in oats at Akron, Colorado. In reviewing the literature they quote seven authors who consider that natural crossing takes place to a greater or lesser extent in oats, and ten who consider that it occurs only very rarely if at all. Their own results showed that the extent of natural crossing varied in different varieties, and even in different head selections within these varieties. The greatest percentage of natural crossing was in the variety Iowar in which an average of nearly one per cent of crosses was found. "In one selection-row of this variety 4.32 per cent of the progeny were natural crosses." In the variety Pringle Progress only 0.05 per cent of known crosses were found.

Crepin (1920) found an intermediate type plant growing in a field of cultivated oats. This when planted segregated to give a very varied progeny. Crepin concludes that it was a natural hybrid between *A. fatua* and *A. sativa*, and that natural crossing in oats, while rare, is probably responsible for much of the degeneration commonly ascribed to reversion. In a letter recently received, M. Crepin informs us that by crossing *A. sativa*, var. Pluie d'Or (= Guldreyn) with *A. fatua* he has succeeded in reproducing in the F_1 the form which he found growing wild, and described in 1920.

III.—Discussion

From the literature herein reviewed it is evident that the aberrant forms of *Avena*, known in Canada and the United States as false wild oats, differ by only one obvious character-complex from the cultivated variety in which they arise. This consists of the long, twisted, geniculate awn, the large, ring-shaped basal articulation, and the stiff hairs surrounding this "sucker-mouth" on both the upper and lower grains of all spikelets. The factor (or group of linked factors) for this complex gives an intermediate result when mated with the normal—the plants from such unions of normal and abnormal gametes being termed heterozygous false wild oats.

The evidence is overwhelmingly against the theory that false wild oats owe their origin to natural-crossing between either *Avena sativa* and *A. fatua*, or between cultivated varieties or individuals of *A. sativa*.

Most of the evidence favours Nilsson-Ehle's hypothesis of a spontaneous change occurring in one or more of the sex cells of a normal plant. Nilsson-Ehle, however, made it clear that he could offer no suggestion of the actual nature of the change involved.

It is obvious from the literature that natural crossing may occasionally occur between *A. fatua* and *A. sativa*, as well as between varieties or individuals of the latter species, but the progeny of such crosses will in practically all cases be very different genotypically from the commonly occurring type here referred to as false wild oats. It is probable that such hybrid forms will often resemble heterozygous false wild oats phenotypically and this fact may be responsible for some of the confusion that has arisen.

There seems to be ample ground for regarding homozygous false wild oats as a distinct subspecies. They reproduce true to type and are readily distinguished from either *A. fatua* or *A. sativa*. They may be described as derivatives of *A. sativa*, distinguished from this species by the presence of twisted, geniculate awns, the distinct basal articulation (or "sucker-mouth") of the grains, and a tuft of hairs on the upper part of the callus surrounding the "sucker mouths" of both the upper and lower grains of every spikelet of the mature panicle. Haussknecht's description of these forms: "*Avena fatua* var *transiens*" is no longer in general usage, and is misleading. We therefore suggest the name "*Avena sativa* mut. *fatuoid*" for all homozygous forms of false wild oats.

While there is much disagreement of opinion on the origin of false wild oats, the only disagreement of fact among the authors quoted is in regard to the segregation ratios of the heterozygous forms. Nilsson-Ehle argues that the divergencies found can be accounted for by the probability that the abnormal gametes are weaker than the normal. There seems to be no reason for questioning the principle of this suggestion. It will be referred to again in a future publication on cytological observations. The existence of divergent ratios cannot be considered very important evidence of natural-crossing, as Zade now seems to contend.

In brief it may be said that the evidence from the literature indicates that false wild oats originate from *Avena sativa* varieties through some spontaneous change occurring in a gamete. Such an abnormal gamete, according to the principle of random fertilization, will usually mate with a normal gamete and give rise to a heterozygous false wild oat plant. Such a heterozygous plant will segregate to give the original pure variety, heterozygous false wild oats, and homozygous false wild oats, generally in a ratio of 1: 2: 1.

The general occurrence of this ratio indicates clearly that usually only a single factor, or a single group of linked factors, is involved in the change. There is, of course, nothing to prevent the occasional direct mating of two abnormal gametes produced by a normal plant and thus the origin of homozygous false wild oats direct from the normal.

It is possibly significant that Percival (1921 p. 355) records concerning wheat that "Changes in the environment appear to stimulate the production of sports. In some seasons, especially those with an abnormally high average summer temperature following severe winters, sports are more frequent than usual in autumn sown wheat. Rimpau records great variation among squarehead wheats throughout Germany in 1903, especially among the bearded forms which had before been very constant and pure.

"Buffum obtained sports in Black Emmer and a Turkey Red Type of *vulgare* wheat immediately after sowing in rich "sagebrush" soil at an altitude of 4000 feet in Wyoming."

The only statement at all analogous that has been found concerning false wild oats is Fischer's report in 1900 that winter sown oats were more liable to "revert" than spring sown oats. In the light of later information this statement may again come to have a significance other than Tschermak considered possible when he stated that it indicated merely that the moist cool weather during which winter oats come into bloom facilitates natural crossing.

It seems possible that environmental conditions may cause abnormalities in the reduction-divisions of the germ-cells (1), and consequently the production in the following generation of speltoid forms of wheat or fatuoid oats. It is, however, a well-known fact that environmental conditions can cause fluctuating variations in the length of the internodes of the wheat head, and in the degree of development of the awns of oats, and this may often be responsible for confusion arising.

Oat varieties which normally have very short awns, may develop quite long ones un-

1 The recent work of Belling, (Journal of Genetics 15: 245-266, 1925) published since the preparation of this paper, supports this suggestion.

der certain conditions, and they may thus easily be confused with heterozygous false wild oats. Such long awns, however, have not usually the sharp bend typical of *A. fatua* or of false wild oat awns, and the grains bearing them will under normal conditions reproduce the original short-awned variety. They are thus very different genotypically from heterozygous false wild oats in which a definite germ-plasm change has occurred which causes them to segregate to reproduce the original variety, their own kind, and homozygous false wild oats, as described. Sometimes the identity of suspected seeds can be definitely settled only by planting them and examining the progeny produced under normal growing conditions.

A further source of confusion which has no bearing on the origin of false wild oats is the fact that oat varieties such as Red Rustproof, which are derived from *Avena sterilis*, often have a base on the primary grains slightly resembling that on all the grains of *Avena fatua* or of false wild oats. Their awns, however, are not usually geniculate as are those of the latter forms, and the upper grains of their spikelets lack the "sucker-mouth."

Without describing the cytological observations so far made in the investigation under way, it may be said that they very strongly support the germ-cell mutation theory of the origin of false wild oats. The present objective of the genetical and cytological investigation is the elucidation of the actual mechanism involved in causing the mutation. Winge's (1924) suggestion that certain chromosome irregularities in the reduction-divisions are responsible for the origin of speltoid forms of wheat is at present being used as a working hypothesis. Considerable cytological evidence supporting this hypothesis has already been found in one strain of false wild oats of the Banner type. It is now being checked with heterozygous false wild oats, and with homozygous false wild oats of the Storm King, Newmarket, and Old Island types, which were kindly supplied by Mr. Norman Criddle of the Dominion Entomological Branch, Ottawa, and Mr. C. W. Leggatt of the Dominion Seed Branch, Calgary.

From the standpoint of practical agriculture the most significant findings are that false wild oats apparently have no direct connection with *Avena fatua*, and that they do not have the property of delayed germination which is characteristic of the real wild oat. It follows from these findings that false wild oats are not as serious a weed menace as they are believed to be by some prominent agriculturists. It is evident that they cannot give rise to *A. fatua*, and since they do not have delayed germination they can easily be destroyed by proper methods of cultivation. Nevertheless, their coarse awns, small percentage of kernel, and easy shattering habit make them very undesirable impurities in seed oats.

Note: Since the above paper was prepared, Dr. Cyril H. Goulden, Dominion Rust Research Laboratory, Winnipeg, has kindly sent us a copy of his, as yet unpublished, thesis "A Genetic and Cytological Study of Dwarfing in Wheat and Oats." The Dwarf oats studied by Dr. Goulden were segregates from false wild oats. In them he found very irregular cytological conditions. Although not arriving at any definite conclusion, he states that "There is evidently in the case of the oat dwarf an intimate correlation between dwarfing, the false wild character, cytological irregularities, and complete sterility." The genetic and cytological findings of Dr. Goulden correspond very closely with our own (Huskins, 1925).

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When Apple Trees First Bear

A table in the report for 1924 of the Dominion Horticulturist, giving the fruit-bearing age of well-known varieties of apple trees indicates that Wealthy is outstanding as an early bearer, with Milwaukee and Dudley as two desirable sorts in this respect. Duchess, the Horticulturist comments, although it has rather a high average, had the most of its trees come into bearing four years after planting, so can also be considered an early bearer.

The age of first bearing, says Mr. Macoun, the Dominion Horticulturist, is important when varieties are to be used as fillers, and the table aims to present this data for the varieties recommended for eastern Ontario and Quebec. Of the best known the average ages of first bearing are given as follows:—Wealthy 3 yrs. 9 mos.; Milwaukee 4 yrs. 3 mos.; Dudley 4 yrs. 5 mos.; McIntosh 5 yrs. 5 mos.; Duchess 6 yrs. 1 mo.; Fameuse 6 yrs. 2 mos. Hibernal is given the mean or average age of ten years but the greatest number of trees bore at five years after planting.

Wheat Quality and Environment

I. Statement of the Problem. II. The Nature of Milling and Baking Quality.

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I. STATEMENT OF THE PROBLEM

The wide variation in milling and baking quality of wheat grown in different areas has long been recognized. Western Canada, for example, is noted for the production of hard red wheat, high in protein, yielding flour of superior baking strength. For this reason Canadian wheat has a special value for the purpose of blending with the weaker wheats produced in less favourable localities. On the other hand, the Pacific coastal States may be cited as an example of a region where the wheat produced is characteristically soft and starchy, yielding flour better suited for making pastry and crackers than bread.

The contrast between the wheats produced in the two regions mentioned is accounted for, in part, by the use of characteristically different varieties, and not entirely by differences in climatic environment. Nevertheless, it has been proved by experiment that the milling and baking quality of the same variety will vary greatly from place to place. It has further been shown that climate is more important than soil in bringing about this result. It must be remembered, however, that the soil is the principal medium through which the climate acts upon the plant. Soil moisture and nitrogen are probably the environmental factors most directly active in modifying the quality of the wheat crop. These two factors are influenced in their turn by climate, soil, and cultural methods, all of which must be considered in a study of the effective environment of the wheat plant.

While the striking differences in the quality of wheats grown in certain widely separated regions, such as Western Canada and the Pacific States, are quite generally known, it is not so commonly realized that within the bounds of our own Prairie Provinces the milling value of the wheat produced varies sufficiently from point to point to affect quite seriously its commercial value. The milling companies have, for their own use, made charts of these provinces, based upon the value of the wheat produced in different districts. The same condition obtains, of course, in other places, and in some States to the south an attempt has been made to establish a quality basis for the sale of wheat, in the form of a guaranteed analysis.

It is possible that in certain districts, regarded with disfavour by the milling companies, a number of farmers may be growing characteristically inferior varieties. In such a case, the introduction of superior sorts is the obvious remedy. But it has been pointed out above that the quality, even of the same variety, will vary greatly from place to place. Where some defect in climatic environment is the cause of the trouble, a remedy is not so easily suggested. It would be of great interest and value, however, to determine by experiment the climatic adaptations of a number of leading, standard varieties of wheat. It is possible that they may all be influenced by any given environment approximately to the same degree and in the same way. If it should prove, on the other hand, that they vary substantially in this respect, it might then be possible to indicate certain varieties, specially adapted to districts now regarded as poor, the use of which could be expected to bring up the general quality of wheat produced in such districts. It would also open up a promising field to the plant breeder, in the production of varieties especially adapted to particular environmental complexes.

To obtain such information a cooperative investigation was launched in 1924, using the following six varieties: Red Fife, Renfrew, Marquis, Ruby, Huron, and Kubanka. Stock seed of these varieties, produced at the University of Alberta each year, is distributed to the following points: Dominion Department of Agriculture Experimental Stations at Lethbridge, Lacombe, Beaverlodge, and Fort Vermilion, Alberta; Department of the Interior Irrigation Experiment Station, Brooks, Alberta; Department of Agronomy, University of British Columbia, Vancouver, B. C. These points represent a wide range of conditions in Alberta, as well as Pacific coast conditions at Vancouver.

Samples of the crop produced by each variety at each point are returned to the Uni-

versity of Alberta, for examination with reference to protein content, value for experimental milling and baking, and various other physical and chemical properties. Cooperators also supply the necessary climatic and phenological records, and soil samples taken at certain critical periods in the growth of the crop.

Obviously such an investigation could not be carried out by any experiment station working alone, and we are very much indebted to the men in charge of the departments and stations listed above for their generous cooperation, and for the interest they have taken in the project.

An important requirement in such an investigation is of course a suitable method or methods for estimating the quality of the wheat produced in the different localities. This point is also of particular interest at the present time because of the growing popular sentiment in favour of a system of "chemical grading" of wheat in commerce. It is considered advisable, therefore, to precede the presentation of our experimental results by a review of the present state of knowledge concerning the nature of milling and baking quality, and methods proposed for its estimation, as well as the relation of this quality to the environmental conditions under which the wheat was produced.

II. THE NATURE OF MILLING AND BAKING QUALITY

Milling Quality

The term "milling quality" is frequently used in the wider sense to include both milling and baking quality. There are, however, some properties pertaining to a sample of wheat which affect only its milling quality, and they may be conveniently considered separately from the much more complicated series of factors affecting baking quality. Milling is a mechanical process, and only the physical properties of the wheat come in question, whereas baking involves physical, chemical, and physiological processes.

Milling quality may be defined as the ability of a wheat to produce a high yield of flour of good colour. Modern flour mills are equipped with very efficient cleaning machinery for the removal of dirt and other impurities from a wheat sample, so that, neglecting the question of cleaning costs and dockage, we need concern ourselves only with the physical properties of the kernels.

The yield of flour may be increased by the miller if he is prepared to sacrifice colour, since these two things are closely related. The greater the separation of flour from bran the greater will be the proportion of branny particles in the finished product.

The moisture content of the grain has an important influence on the flour yield. If the moisture content is well below the legal limit, it is evident that the yield of flour may be increased by the direct addition of water during the milling process. A low moisture content also simplifies the process of tempering, giving the miller greater control of the distribution of moisture throughout the kernel. During tempering the wheat is exposed to sufficient moisture to toughen the branny coat without raising the moisture content of the endosperm. This induces the bran to flake rather than pulverize during the milling, and increases the ease of separation. "Tough" wheat cannot be milled satisfactorily without previous drying. Moist endosperm tends to flake like the bran, resulting in heavy loss of flour in the feeds. Excess moisture content has of course other obvious disadvantages, such as its deleterious effect on keeping qualities.

The plumpness of the wheat kernels is perhaps the most important factor governing flour yield. The ratio of bran to endosperm is more or less a direct function of plumpness in a given variety of wheat, though different varieties may vary considerably in thickness of bran, with consequent effect on the flour yield. The latter point does not appear to have been sufficiently considered by plant breeders in the production of new varieties.

The weight per measured bushel is the most common estimate of plumpness. This may be affected by several factors: the proportion of shrunken kernels, the size and shape of kernels, and their specific gravity (3). Varietal differences in size and shape of kernel may have a great effect on the weight per bushel without corresponding differences in milling value (51). However, this measurement has the advantage of being easily and quickly made, and on the average it is related directly to yield of flour.

The weight per thousand kernels, unless it is very low, appears from the work of Thomas (51) to bear little relation to yield of flour. Varieties having small kernels may give just as high a percentage of flour as

other varieties having large kernels. This will hold true also for differences in size due to seasonal and local conditions. Furthermore, an increase in moisture content will increase the kernel weight but decrease the flour yield.

Kernel volume, on the other hand, was found by Bailey (3) to be directly related to percentage endosperm and flour yield. Since Bailey also found large kernels to have usually a higher specific gravity than small kernels of the same variety, and kernel weight must be a product of volume and density, these results would seem to be at variance with those reported in the last paragraph. The discrepancy may be due to the use of different experimental material. Thomas used a large number of samples belonging to five classes of wheat, while Bailey confined his first experiment to samples of one variety only, cut at six stages of growth, beginning 10 days after flowering, and in a second experiment he compared commercial samples of No. 1 to 4 northern spring wheat. Presumably the lower grades would contain a larger percentage of immature, shrunken kernels. The mode of development of the wheat kernel, in which the envelope is laid down first and the endosperm filled in later, would make a lower flour yield from kernels which have a small volume because of immaturity seem almost inevitable. This may not necessarily follow in a comparison of samples of well matured grain belonging to widely different varieties.

The specific gravity of wheat kernels was also found by Bailey (3) to be an indication of milling value. He believes that the bran and germ tissues have a lower specific gravity than the endosperm structures, thus accounting for the observed increase in density with kernel development, and the usually greater density of large kernels as compared with small ones of the same variety. The density of the endosperm itself exerts an influence on flour yield (3, 31). Yellow-berry, or mealiness, is caused by the formation of interstices along the line of union of adjacent cells and around the starch grains within the latter (37). Such kernels have usually a low specific gravity. In corneous kernels, on the other hand, the cells are completely filled with starch grains embedded in a protoplasmic matrix, the whole forming a dense coherent mass. Hard wheat, of high specific gravity, is generally high in protein, and gives a good flour yield. Not only does the increased density of the endosperm reduce the proportion by weight of the remainder of the kernel, but flinty endosperm mills into granular fragments which are more easily and completely separated from the bran flakes than are the more flaky particles produced by soft endosperm.

The foregoing considerations would seem to provide a basis for the common test of the resistance of kernels to cutting or crushing, on the assumption that hardness is related to protein content and quality. There is considerable indirect evidence to prove this assumption, but published data bearing directly on the point are rather meagre (24, 45), and when they were examined by Roberts (39) together with his own experimental results, he was unable to find any correlation between cracking strain and protein content. Neither could he find in his own work a correlation between specific gravity or kernel volume and protein content. However, some data recorded in one of the papers examined by Roberts (24) showed a correlation between per cent. flinty kernels (judged by appearance) and per cent. protein content, and this has been found to hold in most other experiments on this point (25, 32). It appears therefore that the question of hardness and various other physical properties in relation to protein content merits further investigation.

The ash content of wheat is an indication of potential flour yield from the fact that it is found principally in the outer coats of the kernel. Ash content therefore tends to be inversely proportional to plumpness and milling quality.

The shape of the kernel is a point sometimes overlooked in estimating milling quality. A short plump kernel, with well filled crease, is desirable. From the standpoint of economy in milling the ideal kernel would be perfectly round. In this connection the possible merits of *Triticum sphaerococcum*, Percival, as a carrier of the genetic factor for round shape, might perhaps be canvassed by plant breeders.

The colour of flour produced from clean sound wheat is governed mainly by two factors, the milling process and the type or class of wheat. It has already been mentioned that colour is related to yield of flour, since

the latter may be increased by allowing a less rigid separation of branny particles, which however detract from the pure whiteness of the flour and lower the grade. The size of the granules to which the endosperm is reduced is another factor under the control of the miller. Heavy grinding produces finer granules, which are more easily hydrated in mixing dough, but are inevitably contaminated with more branny particles. The mixing machinery of modern commercial bakeries makes it possible to use flour with coarser granulation, freer from branny particles, and conducive to the production of very white bread. A relationship also exists between ash content and colour, since the ash is found mainly in the branny particles. Millers commonly use the ash content as a check on the grade of flour which their machines are turning out, since it gives a quite sensitive measure of the completeness of separation of the middlings from the outer portion of the kernel.

Carotin, the orange-yellow pigment of the endosperm, is readily oxidized to a colourless compound, a process which takes place naturally with aging of flour, or may be hastened by artificial bleaching. The different classes of wheat, and even to some extent different varieties of the same class, vary considerably in their pigmentation. Of the principal types, Thomas (51) found hard red spring wheat to score highest for flour colour. Most samples of hard red spring and hard red winter yielded creamy-white flour, while in soft red winter he found pure white or grayish-white predominating. Durum wheat he scored down because of the decidedly yellow tinge of the flour produced.

Abnormalities or unsoundnesses of various kinds may affect both yield and colour of flour detrimentally. Immaturity, early frosting, rusting, or any form of damage which checks the development of the kernel and results in shrunken wheat will naturally reduce the percentage yield of flour. Immaturity, frost injury, and sprouting may all cause a graying or darkening of the flour. Heating takes effect first on the odour and flavour of the flour, but it may also injure the colour. In flour produced from old or weathered samples of hard red spring wheat the creamy tint is less pronounced (51). Soil, or smut spores, may darken the flour from certain districts, or in certain seasons, unless the wheat is properly cleaned and scoured.

Some of the foregoing factors will be referred to again in connection with their influence on baking quality.

Baking Quality

The generally accepted definition of quality in wheat flour is "the ability to make large, well-piled loaves, of good colour and texture." The factors contributing to this end are extremely complicated, and constitute a still unsettled and contentious problem. However, the very extensive investigations on the subject, especially in recent years, have considerably elucidated the main points. To assist in following the necessarily somewhat involved discussion of the various factors concerned, this will be preceded by a brief summary.

In order that a loaf of bread shall be large and of good shape, the gluten protein, which provides the supporting framework, must be present in sufficient quantity and of good quality. By gluten quality, we mean that it must possess a large degree of elasticity, and be capable of absorbing a large amount of water without losing its coherence. Various subsidiary factors, such as the acidity of the dough, and the presence of various salts and fatty substances, may modify considerably the absorption and coherence of the gluten.

The expanding force which causes the bread to "rise" is the carbonic acid gas evolved in the fermentation of sugar by the yeast added when the dough is mixed. The sugar naturally present in the flour is small in amount, and the main source of that used in the fermentation is the starch, of which there is always abundance. But before yeast can utilize starch, the latter must be converted to sugar by diastase. The lack of sufficient diastase has been found to be a rather common fault in poor flours.

Providing the production of carbon dioxide gas is adequate, the size, shape and texture of the loaf depend, as already indicated, upon the gluten. It must not permit the too ready escape of gas, and fail of adequate expansion, neither must it rupture into large cavities, or allow the loaf to fall out of shape. It must be capable of spreading out into thin elastic films, forming the walls of the fine cellular structure characteristic of a loaf of good texture.

The colour of bread depends mainly on the colour of the flour from which it is made.

The factors affecting flour colour have been discussed in the previous section. Bread colour may, however, be considerably modified by texture, and so by all the factors influencing texture (26). Low grade flour has a greater tendency to darken during the bread-making process, probably due to the presence of tyrosinase, an oxidizing enzyme, in the branny particles. As colour is relatively less complicated and less important than the other factors involved in bread-making, it will be dismissed with this brief reference, and the following more detailed discussion confined to the factors directly concerned with baking strength.

Proteins

The protein content of wheat was one of the points to receive earliest attention, in connection with milling and baking quality, and it still occupies the position of greatest interest, all the more because it is the only chemical test which has been extensively used for the purpose of commercial grading. Different varieties of wheat, especially if grown under widely different conditions, may vary in protein content from 7 to 18 or 19 per cent.

The proteins of the wheat kernel, with unimportant exceptions, belong to four classes: albumin, globulin, glutelin, and prolamine. Glutenin and gliadin, the gluten proteins, belong respectively to the last two classes. Owing to the lack of exact knowledge as to the chemical constitution of proteins, this classification does not mean much from a chemical standpoint, except in the case of prolamine. This class of proteins is high in proline and glutamic acid.

From a physical standpoint the classification is more significant, as it is based on solubility and coagulability. Albumins are typically water-soluble, and coagulated by heat, alcohol, and complete saturation with ammonium sulphate. Globulins are insoluble in pure water, but soluble in dilute salt solutions. They are coagulated by heat, alcohol, and half saturation with ammonium sulphate. Glutelins are insoluble in water and neutral saline solutions, but dissolve readily in dilute alkali, and in dilute acid under certain conditions. Gliadins or prolamines differ from all other proteins in being soluble in 70 or 90 per cent. alcohol. They are considered *typically* insoluble in water or in salt solutions, though soluble in dilute acids and alkalies. However, wheat gliadin is appreciably water-soluble (43), and about half the proteins of a flour extract made with 1 per cent. sodium chloride consists of gliadin, the other half being albumin and globulin (5).

Though the solubilities of the various wheat proteins are not rigid, the differences can still be made use of in separating them approximately. Suitable solvents for this purpose are 5 per cent. potassium sulphate and 50 to 70 per cent. alcohol (5, 49). Blish and Sandstedt (14) have recently shown that all the proteins of wheat flour, after dissolving in dilute NaOH, remain in solution when methyl alcohol is added to a concentration of 70 per cent., and that the glutenin alone may then be precipitated quantitatively by acidifying with HC1 up to pH 6.4.

From the standpoint of baking quality, gliadin and glutenin, which form over 80 per cent. of the wheat kernel proteins, and nearly the whole of the endosperm proteins (35), are of prime importance. In the endosperm they form the chief constituent of the matrix in which the starch grains are embedded. Albumin and globulin are found mainly in the germ and aleurone layer (35, 10). The size of the salt-soluble fraction of flour proteins furnishes another indication of the grade, since this will be larger in the lower grades which contain more of the outer portions of the kernel. High grade flour will not contain more than 10 to 15 per cent. of its protein in the form of albumin and globulin.

Gluten arises as a hydrated physical mixture of gliadin and glutenin when flour is wetted. Crude gluten however contains about 20 to 25 per cent. of non-protein constituents (35, 18). Gliadin is a sticky substance, adhering to a surface with such force that it will tear off the surface layer of glass in drying. It acts as a binder in the gluten mixture. Glutenin is pasty, but not sticky. It confers on the gluten the property of elasticity.

Originally it was thought that the quantity of gluten was the sole factor in determining the baking strength of flour, and indeed it is still commonly observed that the value of well-matured, sound samples of the same variety, or of closely similar varieties, tends to vary in the order of their protein content. On this basis, however, the behaviour in bak-

ing of the flour of durums and other wheats approaching the wild type in character, which is high in protein, presented an anomaly. After Osborne and Voorhees (36) had shown, in 1893, that gliadin and glutenin make up most of the wheat protein, these began to receive attention. Fleurent (19) claimed that baking strength depended on the ratio of gliadin to glutenin. He found the optimum ratio was 75:25, and that flours which departed widely from this ratio were of poor quality. Snyder (47) supported this view, but found the optimum ratio to be 65:35. He showed, further, that extraction of the salt-soluble proteins (albumin and globulin) did not diminish baking strength. Snyder (48) also drew attention to the importance of gluten quality as opposed to quantity, which he demonstrated by adding up to 20 per cent. starch to flour without affecting its baking strength. Later work, however, has shown that the quantity of gluten must still be regarded as a factor in baking strength, though its importance tends to diminish as the percentage in which it is present increases (28, 32, 51).

A number of investigators (11, 17, 53) have shown that there is no difference in the chemical constitution of the gluten proteins from strong and weak flours. One of these, Blish (11), also showed that the ratio of gliadin to glutenin in different flours was much more nearly constant than had been supposed, discrepancies being explainable by the different analytical methods used. He believes the ratio is usually not far from 1:1 (13). These conclusions focussed attention on differences in physical state of the proteins as the possible cause of differences in baking quality.

Wood (53) and Wood and Hardy (54) investigated the effect of electrolytes on the physical state of gluten. They found acids and bases tended to make it "disperse" or at least slacken off, whereas neutral salts tended to make it more coherent, and thus presumably more efficient in the retention of carbon dioxide. Added salts were less effective than the salts naturally present. Accordingly they concluded that the character and proportion of the electrolytes present determined the physical properties and consequently the strength of the gluten.

Gortner and Doherty (21) and Sharp and Gortner (43) confirmed the fact that the physical properties of any gluten are profoundly modified by the presence of electrolytes, but they showed further that there are inherent differences between glutens from strong and weak flours which cannot be explained on the basis of contained electrolytes, which persist in fact after all the electrolytes have been washed out, and which apparently can be explained only on the basis of differences in colloidal state. These differences are shown in the rate of hydration and capacity for hydration, as measured by the viscosity of flour-in-water suspensions in the presence of small quantities of acids and alkalies. Gortner (20) has published a standardized method for the measurement of gluten quality by viscosity.

Sharp and Gortner also found that the hydration capacity of flour was mainly due to the glutenin, as the viscosity was not reduced by extracting the gliadin. They concluded, therefore, that the differences in the colloidal properties of glutens from strong and weak flours must reside in the glutenin.

The view that glutenin rather than gliadin is the seat of differences in gluten quality is supported by Woodman (55) and Halton (22) on the basis of optical properties. They found the specific rotation and racemization curves of gliadins from strong and weak flours to be practically identical, whereas the glutenins differed significantly in these respects, strength being associated with high specific rotation and weakness with low specific rotation. This would indicate that the glutenins of different flours, while they may be quantitatively identical with regard to the amino acids contained in their molecules, may still be distinct proteins by reason of a different sequence in the linkage of the amino acids. Halton also succeeded in precipitating glutenin in two fractions, differing in optical rotation, which in their turn he considers two distinct proteins, and of which the one with the higher rotation he would expect to predominate in strong wheats.

The findings given in the foregoing paragraph have been seriously called in question by Blish (12, 13), who could find no difference in the optical properties of the glutenins from seven flours differing widely in baking value, except in glutenin from Polish wheat. This variety is rather distantly related to the bread wheats, and in this case the gliadin also differed in optical rotation

from the others examined. Furthermore, no preparation of glutenin could be precipitated fractionally without previous racemization, suggesting that this process may have occurred to a slight extent in Halton's preparation before he fractionated it. It seems, therefore, that any conclusion with regard to a relation between molecular configuration of glutenin and baking quality must be held in abeyance pending further investigation.

A number of additional methods have been proposed at various times for the measurement of gluten quality by physical properties. These are in the main empirical methods, suited to flour control laboratories, for determining the plasticity, elasticity and coherence of dough. One common type of plasticity measurement involves the forcing of a mass of dough through an aperture under standard conditions. In another type the dough is first pressed into thin sheets, and its elasticity and coherence measured by its capacity for, and resistance to, bubble formation under the influence of mechanical or air pressure applied on one side of a circular portion fixed at the circumference between metal plates (7, 30). The same sort of test has been applied to washed gluten.

That the elasticity and coherence of gluten had their practical value in the gas-retaining powers which they conferred on bread dough was recognized by Boland in a test devised in 1848. He measured the volume attained by the gluten washed from 50 grams of flour when heated under standard conditions. The volume increase was a measure of the steam generated from the water in the gluten, and retained in the heated mass. This was taken to indicate the capacity of the gluten to retain carbon dioxide during the fermentation of the dough, and thus to have a direct relation to the size and shape of loaves produced. The expansimeter devised by Bailey (2) and now rather commonly used in baking laboratories, is based on the same principle, but here the complete dough is used, and its expansion measured under the influence of normal fermentation. Bailey and his co-workers have in recent years (6, 9, 28) developed more exact methods for the measurement of the gas-retaining power of dough.

Tests carried out with dough have the advantage of giving a combined measure of several factors at once, including both quality and quantity of gluten, and its behaviour a modified by the presence of various substances, or by treatment during mixing and fermentation. On the other hand, such test have the disadvantage of being difficult t standardize rigidly.

Carbohydrates

The carbohydrates of the wheat kernel include sugars, starch, dextrins, cellulose, an pentosans.

Sugars are present only in small amount in sound wheats. In a series of thirty flour Shutt (46) found the limits for total suga to lie within .62 and 1.22 per cent. This wa mainly sucrose. Reducing sugars varie from traces to .15 per cent. Of the latte glucose is characteristic of the developmental stages, and so will be more abundant i frosted wheat. Maltose, while practicall absent from sound wheat, is produced i large amounts during sprouting. A continuous supply of maltose is also produced b diastatic action during the process of bread making.

The significance of the sugars lies in thei role as yeast food. The natural suppl initially present is however much less important than the supply produced by diastati action during fermentation. The carbon dioxide evolved by the action of the yeast o the sugar causes the dough to expand o "rise". Wood (53) proposed the gas-producing power of flour, incubated with yeast an water, as a measure of its strength, since i indicates the potential size of loaves whicl may be made from it. He pointed out however the coherence of the gluten as the necessary complementary factor for shape of loaves. Bailey (2) drew attention to the fac that size depended upon the ratio betwee the rate of gas production in and the rat of gas diffusion from the fermenting dough Later (6) he devised a method of measurin this ratio. This, of course, is intimately connected with the gas-retaining powers o dough, discussed in the previous section.

While the natural sugar content of flou from sound wheat does not give any indication of flour strength—a deficiency may b easily corrected by the addition of sugar t the dough—a determination of water-solubl carbohydrates is used in some control laboratories as a check on the condition of th wheat. The presence of abnormal amount may mean that the development of the whea

has been interrupted by frost or other agency, or that it has been sprouted or at least stored under conditions favourable to enzymatic action. The increased sugar content is not of itself undesirable, but it indicates the exposure of the wheat to conditions under which proteolytic enzymes may also have been at work, with injurious results to the gluten. As would be expected, a high content of soluble carbohydrates is regarded much more seriously in a low-protein wheat than in a high-protein wheat.

Starch is the predominating constituent of the endosperm of wheat, and makes up about 70 per cent. of middlings flour. From the point of view of flour strength its chief importance is that through diastatic action it yields the sugar necessary for panary fermentation.

The starch grains occur in various sizes, from 3 to 5 microns up to 30 to 35 microns in diameter. While the smallest granules preponderate in quantity, the proportion of large grains in different flours may vary from about 1½ to 6 per cent. of the total number, or 7 to 40 per cent. of the total weight. Armstrong (1) points out that before a starch grain can be converted into sugar the cellular envelope has first to be destroyed by the enzyme cytase, and that, obviously, when the envelope of a large granule is destroyed a much larger proportion of starch is rendered available than when the contents of a small granule are liberated. Further, he cites the observation of Whymper that in the germination of wheat the larger granules are affected by digestive enzymes sooner than the smaller granules, The presence of a good proportion of large granules in flour would thus be expected to favour gas-production and strength.

On the other hand, Buchanan and Naudain (15), in a preliminary study with seven typical flours, found an inverse relationship between the average size of starch grains and loaf volume. They cannot yet say, however, whether the size of the starch grains is a determining factor, or merely an index of the conditions under which the endosperm of the wheat was laid down, and which may have modified the colloidal state of the gluten. In this connection the possible influence of the size and number of embedded particles on the sponge structure and mechanical properties of gluten in bread dough, as pointed out by Hardy in 1909 (23), should be borne in mind. This does not appear to have been investigated as yet, except in a limited way by the dilution of flour with starch, in work mentioned earlier in this paper (28, 48).

A possible insufficiency of enzymic activity, as a factor militating against flour strength, has been suggested in the case both of cytase and diastase. Apparently the significance of starch grain size in any particular flour sample would vary according to which of these enzymes were deficient. However, that differences in the ease of hydrolysis of the starches of different flours do exist was shown again by Collatz (16), who found that in general weak flours, when digested for an hour with a given quantity of malt preparation, produced less sugar than strong flours under the same conditions.

Additional evidence that variation in the physical properties of starches of different flours may exert an active influence on their baking quality is furnished by the recent work of Rask and Alsberg (38) on the viscosity of starch pastes. These authors found high starch viscosity to be associated in a number of cases with low loaf volume and low protein content, as well as with winter habit of growth in the plants of origin. Low viscosity was associated with the opposite conditions.

The remaining carbohydrates are of minor importance. Dextrins occur to the extent of about 3 per cent. of the kernel. Being compounds intermediate between starch and sugar, they have no independent significance except that the presence of abnormal amounts may indicate sprouting. Cellulose and pentosans are found chiefly in the pericarp, and only to a small extent in middlings flour. Since the completeness of separation of the endosperm from the remainder of the kernel largely determines flour yield and grade, the pentosan content of flour has been proposed as an index of the efficiency of milling (27).

Fat

About half the total fat of wheat is in the germ, of which it comprises from 13 to 15 per cent. In flour the fat content varies from 1 to 1½ per cent., according to the locality in which the wheat was grown (1) and the efficiency of milling. Millers try to obtain flour as free as possible from fat, since its presence indicates incomplete separation of the germ, and the latter contains enzymes which are deleterious to bread dough.

Although the addition of fat to introduce "shortness" in certain baked products is a very old practice, the effect of the natural fat content on the physical properties of gluten, in relation to baking quality, seems not to have been investigated until recently. Fats are exceedingly surface-active substances, which might be expected to become distributed at the interfaces of the protein mesh-work, thus reducing the coherence of the mass, or "shortening" the gluten. Acting on this assumption, Working (56) tested the effect on gluten quality of both extracting and adding fatty substances. He found that prolonged washing of the soft gluten from low-grade flour, with distilled water, removed phosphatide and gradually increased the tenacity until the gluten was practically equal to that from patent flour; also that the addition of various water-soluble lipoids, and even non-lipoid substances which reduce surface tension, was injurious to the gluten quality, the degree of injury varying with the amount added. On the other hand, in practical baking tests, Saunders and his co-workers (41) found the apparent flour strength to be improved in most cases by the addition of 3 per cent. of a variety of fats.

With regard to possible surface effects of fats, we might speculate that these substances are also adsorbed to some extent on the starch grains, thereby interfering with diastatic action, and perhaps accounting in part for the varying resistance to diastase of the starches of different flours.

Ash

The ash of wheat amounts to about 1.5 to 2 per cent. of the weight of the kernel. Over half consists of phosphates, derived chiefly from organic compounds, such as phytin in the bran, and lecithin and nucleo-protein in the germ. Mineral matter in the endosperm is so small in amount that, as mentioned earlier, the per cent. ash in flour is commonly used by millers as a check on the completeness of separation of the parts of the grain. High grade flour seldom contains more than 0.5 per cent., whereas bran usually has over 5 per cent.

The electrolytes in flour, though small in amount, exercise a very important effect on strength. The investigations of Wood (53) and Wood and Hardy (54), mentioned in the discussion on proteins, showed that salts confer cohesion on gluten, while dilute acids and alkalies cause it to slacken off, or lose strength.

The acidity of flour and dough depends upon both organic and mineral compounds, but for convenience the questions of salt and acid effects will be included together in this discussion of ash constituents.

The effective acidity, or hydrogen-ion concentration, exerts an influence in several different ways. Jessen-Hansen (29) was the first to show that an acidity in dough equivalent to pH 5 represents optimum conditions for bread-making. The reasons for this have been summarized by Bailey and Sherwood (8) as follows: (1) The isoelectric point of gluten, or the hydrogen-ion concentration at which it is most coherent and elastic, is at pH 5; (2) the rate of yeast fermentation apparently reaches a maximum at pH 5; (3) flour and malt diastase reach their optimum activity, other things being equal, at about pH 5; (4) rope-producing organisms are apparently almost inactivated in a medium more acid than pH 5.

The first of these reasons may require modification. Blish and Sanstedt (14) have shown that the isoelectric point of glutenin appears to undergo a change during preparation by the usual method of Osborne (35), owing to the prolonged and frequent treatment with alkali. Prepared by the Osborne method, it precipitates at pH 5.2; prepared by their new method, it precipitates between pH 6.0 and 6.8. Doubt is also thrown upon the correctness of the older value by the recent investigations of Tague (49, 50), who assigns pH 6.5 and 7.0 as the respective isoelectric points of gliadin and glutenin.

It appears, therefore, that gluten in dough is usually at a hydrogen-ion concentration on the acid side of its isoelectric point, a condition which would stimulate absorption of water. However, the slackening-off or dispersion, observed by Wood and Hardy to be the effect of acids, is generally sufficiently counteracted by the salts naturally present in strong flours. The salt concentration of weak flours is frequently bolstered up by the addition of so-called "flour improvers." These commercial preparations usually contain salts intended to stimulate yeast growth as well as salts which "firm" the gluten.

Among the salts contained in flour are some, such as phosphates, which act as "buffers." These are substances which ionize readily in solution, and tend to prevent rapid

hanges in hydrogen-ion concentration on the ddition of acid or alkali. As they occur main-y in the bran, the lower grades of flour, which contain more branny particles, are aturally more highly buffered.

Enzymes

The enzymes known to be present in wheat lour include diastase, which produces mal-ose from starch; phytase, which decomposes hytin into phosphoric acid and inositol; atalase, which sets free oxygen from per-xides; and proteases, which split proteins nto proteoses, peptones, and amino acids. The foregoing have all been extensively stud-ed. Others, less well authenticated, include ytase, which acts upon cell-wall substances, nd may be necessary to digest the envelope f starch grains; and tyrosinase, an oxidizing nzyme which produces a black pigment from yrosin, and which is probably responsible or the darkening of wetted flour containing ranny particles.

Since the amount of sugar naturally pre-ent in flour is entirely inadequate to sup-port the necessary yeast fermentation, the mportance of diastase is evident. Rumsey (40) developed a method for determining the iastatic activity of flour, using the flour it-elf as the substrate, and showed that the de-ree of activity bore a direct relation to bak-ng strength. He found pH 4.7 the optimum eaction for flour diastase, at a temperature f 27°C. Temperature had a greater in-luence than hydrogen-ion concentration, the maximum production of maltose occurring at 3.5°C. Olsen and Fine (34) have recently hown that the optimum hydrogen-ion con-entration for malt diastase varies from pH .3 to 6.0 as the temperature is raised from 5° to 69°C. The effect of adding malt pre-parations to flours was studied by Collatz (16), who found that the gas-producing pow-er was thereby greatly increased in weak lours but not in strong flours.

Phytase is confined mainly to the bran nd aleurone layer, but finds its way into lour with the branny particles. The acid hosphates set free in the hydrolysis of phy-tin probably contribute to the increasing ydrogen-ion concentration of flour with age, while at the same time stabilizing the reaction y their buffer effects.

Catalase is also found mainly in the outer ortions of the kernel. Bailey (4) found it to be closely correlated with the ash content of flour, as might be expected from the dis-tribution of these two constituents in the wheat grain. He suggested catalase activity as a test for distinguishing flour grades, more easily and quickly carried out than the de-termination of ash.

The proteases of wheat flour are of inter-est chiefly because of their possible deleter-ious effect on the gluten. In common with most other enzymes of wheat, they appear to be concentrated chiefly in the germ and outer portions of the kernel. High grade flour does not contain sufficient to cause appreciable chemical change during the normal period of fermentation, though Sharp and Elmer (42) suggest that changes may be caused in the colloidal properties which would de-finitely affect flour strength. Their experi-ments showed that auto-digestion of flour pro-teins will take place if the process is given sufficient time. Sharp and Gortner (44) found that the addition of malt preparations caused a definite degradation of the colloidal properties of glutenin, as shown by a reduc-tion in water-imbibing capacity, during the ordinary period of fermentation, which they attributed to the action of proteolytic enzy-mes. Olsen and Bailey (33) concluded, how-ever, as a result of their work on the effects of yeast proteases, that the reduction in water-imbibing capacity of the gluten was due to the increasing hydrogen-ion concentration during the 4- to 5-hour fermentation period, and that the effect of the proteases in this time was negligible.

Fermenting enzymes of various kinds are active in bread dough, but these have their origin perhaps exclusively in the micro-organic flora, including the added yeast, rath-er than in the flour itself. Bailey and Sher-wood (8) believe that the increase in hydro-gen-ion concentration during fermentation is due chiefly to organic acids resulting from the activities of acid-producing bacteria.

THE BAKING TEST

The baking test is still the most common method of evaluating flour, and it has ob-vious advantages. On the other hand, it has several disadvantages. It requires the mill-ing of a rather large sample of wheat, thus postponing the possibility of early tests of

new wheat strains. It is difficult to standardize rigidly, and in any case it would not be possible to develop one standard method equally suited to all flours. Apparent flour strength may be considerably modified by treatment during the bread-making process. Weaver and Goldtrap (52) suggested dropping the designations "strong" and "weak", and substituting therefor the terms "flour of long fermentation period," and "flour of short fermentation period." While it seems unlikely that the baking test will ever be entirely superseded by simpler physical or chemical measurements, it is advisable, where accurate comparisons are important, to check it by other methods.

SUMMARY

The chemical composition and physical and biochemical properties of wheat and flour have been extensively investigated in their relation to milling and baking quality. A number of tests have been devised which in the aggregate at least enable us to evaluate different wheat samples with moderate accuracy. It is clear, however, that a great deal more work is required on nearly every important point before we can hope to gain anything approaching a full and satisfactory understanding of the problem.

The principal factors involved in flour strength are summarized graphically in Figure 1.

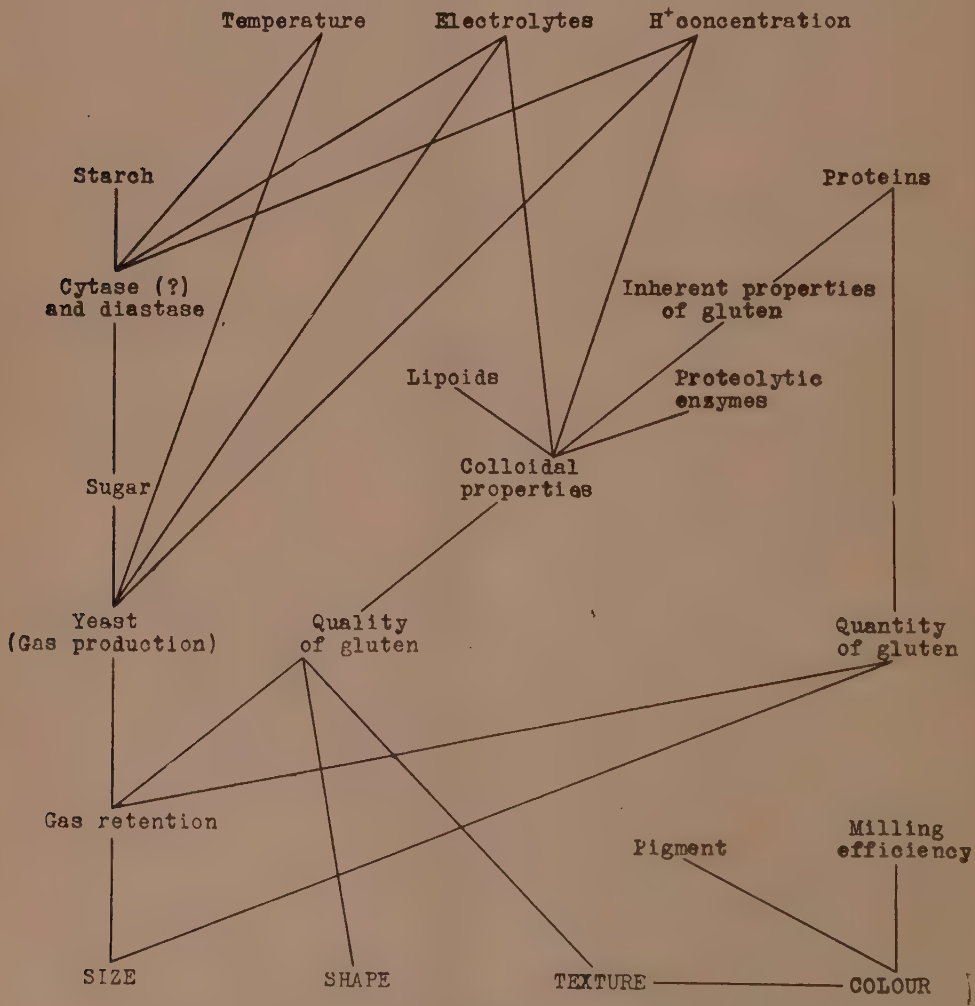

Figure 1. Factors in Flour strength. (Newton and Malloch)

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Report of the Committee on Educational Policies*

L. S. KLINCK, *Chairman.*

Your Committee beg to report the following:

Report and Recommendations:

Two years ago the Committee on Educational Policies presented to the Saskatoon Convention a progress report in which the "tendencies" as these pertain to agricultural education in Canada were indicated. Last year a report, dealing with the main features of existing agricultural education and embodying the "conclusions" reached, was submitted to the Convention which met in Guelph. Although these reports contained much valuable information, it was felt that the study had not been sufficiently exhaustive to warrant specific recommendations being made at that time, and the Convention instructed the Committee and its two sub-Committees to continue their work so that, if possible, definite recommendations might be made at this meeting.

The recommendations herewith submitted are based on the previously mentioned reports, supplemented by data which have been brought together during the past year. The recommendations of the sub-Committee on Agricultural Educational Policies in Public and High Schools, which have been prepared under the chairmanship of Mr. J. W. Gibson, will be submitted first. This will be followed by the recommendations of the Main Committee dealing with Educational Policies in the Colleges of Agriculture. The sub-Committee on Educational Policies in Agricultural Schools is not prepared at this time to make definite recommendations.

RECOMMENDATIONS

PART I

Public and High Schools

A. Public Schools

1. *Re Qualifications and Preparation of Teachers.*

   That teachers' training courses in agriculture and related sciences be established in all normal schools and that supplementary agricultural courses for teachers in provincial summer schools be adequately supported.

PROPOSED AMENDMENT:

"That teachers' training courses in elementary science be established in all normal schools and that supplementary courses for teachers in provincial summer schools be adequately supported".

2. *Re Status of Agriculture in the Public School Curriculum.*

   That the teaching of agriculture in the three higher grades be made compulsory in all rural schools and interchangeable with a parallel course in general nature study and elementary science in urban schools.

PROPOSED AMENDMENTS:

1. "That the teaching of elementary science in the three higher grades be made compulsory in all schools".
2. "That 'three' be deleted".
3. "That the teaching of Agriculture in the two higher grades be made compulsory in all rural schools, to be preceded by a gradation of nature studies suitable to the ages and experiences of the pupils".

NOTE: (In view of the lack of qualified teachers, one member thought this recommendation was too strong).

3. *Re Method of Teaching.*

   That some form of practical work of an agricultural character be required as an essential part of the course in elementary agriculture, such as school gardening, school supervised home gardening or other forms of agricultural home project work.

PROPOSED AMENDMENT:

"That some form of practical work be required as an essential part of the course in elementary science".

4. *Re Organization and Management.*

   That all agricultural instruction in public and high schools be under the direction and control of Provincial Departments of Education.

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* Presented at the C.S.T.A. Convention at Edmonton, Alta., June, 1925.

PROPOSED AMENDMENT:
"That 'agricultural' be deleted".

5. *Re Organization and Scope of School Fairs.*
   a. That school fairs be organized primarily for educational purposes and be so conducted as to represent achievement in all lines of school and allied home activities.

PROPOSED AMENDMENTS:
1. "That 'exhibits' be substituted for 'fairs'".
2. "That 'exhibitions' be substituted for 'fairs'".

   b. That school fairs come under the general direction and control of Provincial Departments of Education.

PROPOSED AMENDMENTS:
1. "That 'exhibits' be substituted for 'fairs'".
2. "That school fairs come under the joint direction and control of departments of Education and Departments of Agriculture".

NOTE: (One member was not opposed, in principle, to this sub-section, but suggested that it be deleted.)

6. *Re Organization and Management of Boys' and Girls' Clubs.*
   a. That all projects conducted in boys' and girls' clubs be given a close and definite relationship to the teaching of agriculture and home economics in the schools.

PROPOSED AMENDMENT:
"That 'elementary science' be substituted for 'agriculture and home economics'".

   b. That the general management and organization of all such clubs be under the direction of Provincial Departments of Education.

PROPOSED AMENDMENT:
"That 'Agriculture' be substituted for 'Education'".

NOTE: (By boys' and girls' clubs is meant organized groups of boys and girls (10 years of age and over), whose work is the more effective development of the project work referred to in 3 and not groups of more mature persons (16 to 21 years of age) where the emphasis is placed on skill in economic production.)

6. c. That junior farmers' clubs for more mature out-of-school boys (18 to 21 years of age)—in which the emphasis is placed on skill in economic production—be organized under the general direction of Provincial Departments of Agriculture.

PROPOSED AMENDMENT:
"That 'Provincial Departments of Agriculture' be changed to 'Extension Departments of Colleges and Universities'".

NOTE: ("c", and the proposed amendment thereto, are not to be considered as recommendations. They were left in to make the meaning of certain of the previous recommendations clear.)

B High Schools

1. *Re the Teaching of Agriculture in High Schools.*
   a. That agriculture be accorded equal rank and credit with other high school science subjects.
   b. That high school courses in agriculture occupy not less than two years of regular instruction with a minimum of four periods per week.
   c. That the courses offered in agriculture be made definitely concrete and practical through the use of laboratory and demonstration gardens supplemented by agricultural home projects.

PROPOSED AMENDMENT:
c. "That courses offered in Science and Agriculture be made concrete through the use of laboratory and demonstration gardens supplemented by agricultural home projects".

   d. That Provincial Departments of Education be urged to recognize the importance of this method of instruction by making special grants to school boards toward meeting cost of same.

PROPOSED AMENDMENT:
"That 'adequate' be substituted for 'special'".

2. *Re Qualifications and Preparation of High School Instructors in Agriculture.*
   a. That General Science and Agriculture be made compulsory as part of the academic training of all prospective teachers of rural schools.

PROPOSED AMENDMENT:

"That General Science be made compulsory as part of the academic training of all prospective teachers".

b. That as far as possible the teaching of agriculture in high schools be carried on by agricultural graduates.

PROPOSED AMENDMENT:

"That 'as far as possible' be deleted".

c. That agricultural college graduates be eligible to obtain professional standing as Specialists in science on the same terms as graduates in the Faculty of Arts.

PROPOSED AMENDMENT:

1. "That 'teachers' be substituted for 'Specialists'".
2. "That 'and Science' be added after 'the Faculty of Arts' ".

d. That in order to qualify as teachers of science and agriculture in secondary schools, agricultural graduates be required to take a full course in a normal training college or faculty of education.

e. That agricultural graduates who, previous to graduation, have completed a full normal school course, be granted professional standing as teachers in secondary schools.

NOTE: (Two members of the Committee regard this recommendation as being too generous.)

f. That on the approval of the Department of Education agricultural graduates who have had satisfactory experience as instructors in agriculture, but who have not had normal training, be permitted to obtain professional standing on the completion of at least two approved summer courses in education.

PROPOSED AMENDMENT:

"Substitute 'who give satisfactory evidence of teaching ability in Agriculture' for 'who have had satisfactory experience as instructors in Agriculture' ".

3. That special winter courses of not less than four months' duration be organized in suitable districts for the benefit of young men and women 16 to 21 years of age, and that the study of agriculture and home economics occupy at least half the time devoted to such courses.

NOTE: (Some members of the Main Committee were of the opinion that subsection 3 should be deleted.)

Signed - J. W. Gibson (Chairman)
F. W. Bates
J. B. Dandeno
L. A. DeWolfe.

PART II.

Agricultural Schools

The sub-Committee on Educational Policies in Agricultural Schools is not prepared to make recommendations at this time.

Signed - L. S. Klinck (Chairman).
H. A. Craig
A. T. Charron
W. J. Bell

PART III.

Agricultural Colleges

1. *Re the Relation of the Colleges to the Provincial Department of Agriculture.*
   That agricultural colleges be constituted independent of departments of agriculture.
2. *Re the Relation of the Colleges to the Provincial Departments of Education.*
   a. That colleges and faculties of agriculture be made directly responsible, through their governing bodies, to the Minister of Education.

PROPOSED AMENDMENTS:

1. "That colleges and faculties of agriculture be made directly responsible, through their governing bodies, to the Lieutenant Governor in Council".
2. "That colleges and faculties of agriculture be made directly responsible, through their governing bodies, to the Minister of Education or to the Lieutenant Governor in Council".

b. That Agricultural Colleges and Faculties of Agriculture sustain the same relationship to their respective universities as that sustained by other colleges or faculties.

3. *Re Associate Courses.*
   That the associate course, when offered, be separate and distinct in curriculum and instruction from the degree course.

NOTE: (One member of the Committee objected to the inclusion of this recommendation.)

4. *Re Matriculation Standards for Degree Courses.*

That the requirements for admission to the Faculty of Agriculture be equivalent to, and interchangeable with the requirements for admission to the Faculty of Arts.

PROPOSED AMENDMENT:

"That 'all other faculties' be substituted for 'the Faculty of Arts' ".

NOTE: (One member of the Committee objected to the inclusion of this recommendation.)

5. *Re Undergraduate Courses.*

a. That the greater part of the first two years of the undergraduate course be devoted to the humanities and to pure science.

PROPOSED AMENDMENT:

1. "That 'pure' be deleted".
2. "That 'first and second' be substituted for 'first two' ".

NOTE: (One member of the Committee objected to the inclusion of this recommendation.)

b. That the greater part of the second two years of the undergraduate course be devoted to the applications of science to the practice of agriculture.

PROPOSED AMENDMENT:

"That the greater part of the third and fourth years of the undergraduate course be devoted to the applications of pure science to the art and science of agriculture."

c. That the principle of electives be adopted for the third and fourth years. (To permit of a major emphasis.)

d. That specialization be reserved for graduate study.

PROPOSED AMENDMENT:

"That specialization, as such, be reserved for graduate study".

6. *Re Graduate Courses.*

That in view of the higher standards of professional training now demanded of graduates in agriculture, better opportunities and facilities be provided for post-graduate work in Canada.

PROPOSED AMENDMENTS:

1. "That 'post' be deleted".
2. "That 'in agriculture' be substituted for 'in Canada' ".

Your Committee strongly recommends that steps be taken by this Convention, through the appointment of a small committee, or otherwise, to ensure that the recommendations, as approved by this Convention, be brought to the attention of the Department of Education and the Department of Agriculture in each of the provinces, to the Dominion Department of Agriculture, and to the Agricultural Colleges of Canada.

PROPOSED AMENDMENT:

"Your Committee strongly recommends that steps be taken by this Convention, through the appointment of a small committee, or otherwise, to ensure that such recommendations as are approved by this Convention, be brought to the attention of the Department of Education and the Department of Agriculture in each of the provinces, to the Dominion Department of Agriculture, and to the Agricultural Colleges and Faculties of Agriculture in Canada".

Signed.- L. S. Klinck (Chairman)
H. S. Arkell*
W. J. Bell
M. Cumming
C. Gagne
F. C. Harrison
E. A. Howes
C. H. Lee
Rev. Father Leopold
J. B. Reynolds
W. J. Rutherford.

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* Mr. Arkell has disapproved of the report as published, and his comments will be published in a later issue, together with any suggestions or criticisms that may be submitted by other members of the C.S.T.A.—Ed.

Concerning the C.S.T.A.

APPLICATIONS FOR MEMBERSHIP

During the month of August five French-speaking members joined the Society, as follows:

Brien, France (Montreal, 1922, B.S.A.) Amos, P.Q.

Daviault, Lionel (Montreal, 1924, B.S.A.) Montreal, P.Q.

Giasson, G. L. (Montreal, 1925, B.S.A.) Montreal, P.Q.

Raynauld, Robert (Montreal, 1925, B.S.A.) Montreal, P.Q.

Trépanier, René (Montreal, 1924, B.S.A.) Oka, P. Q.

NOTES

J. E. Lattimer, (O.A.C. '14) was in Ottawa recently. He is taking graduate work, towards his Doctor's degree, at the University of Wisconsin, specializing in Agricultural Economics.

P. H. Ferguson (O.A.C. '20) has completed his M.S. course in Agricultural Economics at the University of Wisconsin. He paid a short visit to Ottawa about the middle of August.

W. G. MacDougall (Macdonald '15) has been appointed Assistant Superintendent of the Dominion Experimental Farm at Lennoxville, P.Q. He was formerly County Agriculturist at that point under the Quebec Department of Agriculture. The latter position is to be filled by the transfer of A. F. Bothwell (Macdonald '17) from Lachute, P.Q.

S. C. Barry (University of B.C., '23) has been appointed Assistant Chief of the Poultry Division in the Dominion Live Stock Branch, succeeding E. Rhoades (Macdonald '12) who is now Secretary of the World Poultry Congress, to be held at Ottawa in 1927, and has his office at the Central Experimental Farm.

H. J. M. Fiske (Macdonald '14), who has been connected with the wholesale fruit business in western Canada for some years recently took over the business of a large wholesale fruit firm at Ottawa. His private address is Y.M.C.A., Ottawa.

MEMBERSHIP CAMPAIGN

The General Secretary has completed the preparation of a C.S.T.A. "Booklet of Information", which is to be used as the basis for a membership compaign to be launched on September 15th. The Booklet will also be sent to members of the Society and to the senior students at agricultural colleges, who are now eligible to join the Society as Student Members.

At the close of the membership campaign a complete alphabetical list of members will be prepared for general distribution. This will be ready in January, 1926, and its publication will be followed immediately by the organization and development of the C.S.T.A. Bureau of Employment. It is hoped that the latter will become active early in March, 1926.

ARTICLES IN THIS ISSUE

The first two articles in the present issue record the results of important investigations by members of the Faculty of Agriculture at the University of Alberta. They have been published promptly as a courtesy to the authors, and we feel sure they will be read with interest by many of our members. The October issue will contain several articles of a more popular type.

Members are asked to contribute to the discussion on the report of the Committee on Educational Policy, which appears in this issue. It is hoped that discussion will be sufficiently keen and constructive to permit the Committee to bring in a final report at the 1926 Convention.

ABSTRACTS

At the Edmonton Convention, the opinion was expressed that a certain number of pages of the official organ should be used each month for the publication of short abstracts of the most important agricultural bulletins, articles, etc., published by Canadian authors. An effort will be made, in the near future, to put this arrangement into effect, and the cooperation of members of the Editorial Board is now being sought for that purpose.

La Revue Agronomique Canadienne

RÉDACTEUR—H. M. NAGANT

NOUS VOULONS ETRE MILLE

Mille membres, dont au moins 250 canadiens français, tel est l'objectif qu'a décidé d'atteindre, à bref délai, la C.S.T.A., lors de sa dernière convention annuelle tenue à Edmonton du 24 au 26 juin. A cet effet, il a été résolu d'organiser une vigoureuse campagne de recrutement à laquelle toutes les bonnes volontés, toutes les initiatives dévouées et intelligentes sont instamment invitées de participer.

D'autre part, pour faciliter l'accès des nouveaux membres, ceux-ci seront admis, dans l'association, sans versement de droit d'entrée, par conséquent sur simple paiement de la cotisation annuelle de 6 piastres qui leur assurera tous les avantages de la société, pendant la durée d'une année, à partir de la date d'inscription. Toutefois il est entendu que ce privilège n'est valable que jusqu'au 31 décembre 1925.

Ainsi que le faisait observer un des membres du conseil exécutif de la C.S.T.A., cette dernière mesure permettra de faire definitivement le partage entre les agronomes qui ont à coeur le prestige et le progrès de leur corps professionnel et, comme corollaire, leur avancement individuel, et ceux qui veulent rester des isolês, ignorant les besoins généraux de la profession, indifférents à ses aspirations, mais ignorés aussi de la collectivité lorsqu'ils auront besoin de son appui.

En avant donc! Chaque membre actuel devrait avoir à coeur de faire au moins une recrue parmi les gradués en agriculture de ses connaissances qui ont négligé jusqu'ici de s'inscrire dans notre société. Ajoutons de nouvelles pierres à cet édifice de la profession agronomique, au Canada, qui s'élève de plus en plus imposant sur les fondations jetées voici cinq ans maintenant.

Avec un effectif de 1000 membres, tous animés d'un même idéal, tous décidés à suivre le même programme, poussant tous vers les mêmes réalisations pratiques, nul n'en peut douter, la C.S.T.A. constituera ce corps réellement puissant, disposant de tous les moyens matériels et moraux pour accomplir la mission qui lui incombe.

NOUVELLES DE NOS MEMBRES

Nous apprenous avec plaisir que nos deux confréres, Firmin Létourneau et Joseph Bisson ont conquis leur diplôme à l'Ecole des Sciences Sociales et économiques de l'Université de Montréal.

Nos fèlicitations à ces confrères qui durant leur sejour dans la grande ville ont su utiliser leurs soirées de manière plus profitable et plus intèressante que dans la frèquentation des cinémas et des théatres.

AVIS

Les membres de section de Montréal de la C.S.T.A. sont priés de tenir compte lorsque sera annoncée la prochaine réunion que le Cercle Universitaire a quitté la rue St Hubert depuis le mois de juin dernier et est actuellement installé, dans son hôtel, au numéro 361 de la rue Sherbrooke Est, à aouche en allant de St. Denis à St. Hubert.

BIBLIOGRAPHIE

La Science du Sol.

Annales des laboratoires G. Truffaut Agronomie-Bactériologie-Chimie- et physiologie végétale-Entomologie- Phytopathologie Uoologie. (Librairie des Etablissements Georges Truffaut, 90 bis, Avenue de Paris Versailles, France).

Nous accusons réception du volume IV mars 1925, de cette publication, brochure de 55 pages, formant une contribution nouvelle à l'étude de la nutrition azotée des plantes intitulée:

"Fixation de l'azote gazeux par des plante autres que les légumineuses."

D'après les auteurs, qui sont messieurs G. ıffaut et N. Bezssonoff, leurs études ont duit à la conclusion que des plants de ïs élevés dans des milieux dépourvus zote et de carbone, évoluent normalement ınd ces milieux sont inoculés par certaines tériers fixatrices d'azote.

Les auteurs rappellent d'abord quelles sont ne manière générale les idées actuelles connant la nutrition azotée des plantes supéıres; idées qui semblent bien établir les is modes suivants d'assimilation: 1o Symse étroite de certaines plantes supérieures c les micro organismes fixateurs (léguminees, aulnes, myriacées, etc.). 2o Fixation zote par des bactéries libres, trouvant dans sol suffisamment de matériaux énergétis pour remplacer le sucre des cultures de oratoire. 3o Assimilation par l'interméde d'algues vivant en association avec des tériers fixatrices d'azote, les algues fournist aux bactéries les hydrates de carbone sert de matériaux énergétiques.

Ensuite une conception nouvelle relativent à l'assimilation de l'azote par les plantes érieures est émise. Celles-ci secrèteraient leur racines des matériaux énergétiques, s forme d'hydrates de carbone ou d'acides aniques, dont se serviraient les bactéries res du sol pour fixer l'azote qu'elles past ensuite à ces végétaux supérieurs. Il y ait donc autour des racines de ces plantes zone d'échange entre leurs sécrétions et les des bactéries, appelée "*rhizosphère.*"

Les auteurs prétendent avoir établi expérintalement ce fait pour le mais cultivé en lieu totalement dépourvu de carbone et zote combiné, mais inoculé avec certaines tériers fixatrices d'azote. Suit une desotion détaillée de la technique opératoire vie dans les expériences de culture en mil- stérile liquide et milieu stérile solide, c ensuite application de ces méthodes à essais sur le mais. Cette description est ompagnée de plusieurs clichés, dont quels-uns en couleur, donnant une représenon bien nette des opérations effectuées.

Dans les cultures restées stériles, le mais se développa pas, tandis que dans celles inoculées les plantes acquirent un accroisnent normal avec assimilaton correspondante d'azote. Ce qu'il y a de tout à fait remarquable dans l'expérience, c'est la proportion énorme d'azote fixé, comparativement aux quantités de substance énergétique secrétée par les racines de mais, sous forme de sucres et d'acides organiques. Suivant les calculs des auteurs, cette proportion serait approximativement d'une partie d'azote pour une partie de matière énergetique secrétée, calculée sous forme de sucre, alors que dans les expérences de cultures en laboratoire, avec sucre fourni artificiellement, nous sommes bien loin de ce résultat si économique. En effet, toujours d'après les auteurs mentionnés, les meilleurs coefficients obtenus jusqu'ici dans ce genre d'expériences (Lippmann) se rapprochent de $^1/_{50}$ (1 gramme de sucre consommé pour 20 milligrammes d'azote fixé), alors que règle générale ces proportions oscillent plutot entre $^1/_{250}$ et $^1/_{500}$.

Voici maintenant, transcrites littéralement, les conclusions générales que formulent messieurs G. Truffaut et N. Bezssonoff pour terminer l'exposé de leurs recherches:

1o "En présence de bactéries fixatrices d'azote, des mais se développent normalement et arrivent à maturité dans un milieu dépourvu d'azote et de matières organiques.

2o Les sécrétions des racines du mais suffisent à tous les besoins alimentaires des racines du mais suffisent à tous les besoins alimentaires des bactéries fixatrices d'azote en matériaux énergétiques.

3o Dans ces conditions le rapport:

$$\frac{\text{azote}}{\text{matériaux énergétiques utilisés}}$$

est de beaucoup supérieur aux meilleurs coéfficients obtenus jusqu'ici dans les cultures bactériennes au laboratoire, et aussi dans les sols enrichis artificiellement en sucres ou en cellulose.

4o Il semble également établi qu'en ce qui concerne le travail de fixation microbienne de l'azote dans le sol arable, le clostridium Pastorianum joue un rôle important."

H. M. N.

Les Tissus Histologiques et le Microscope Polarisan

OMER CARON

Botaniste, Ministère de l'Agriculture, Québec

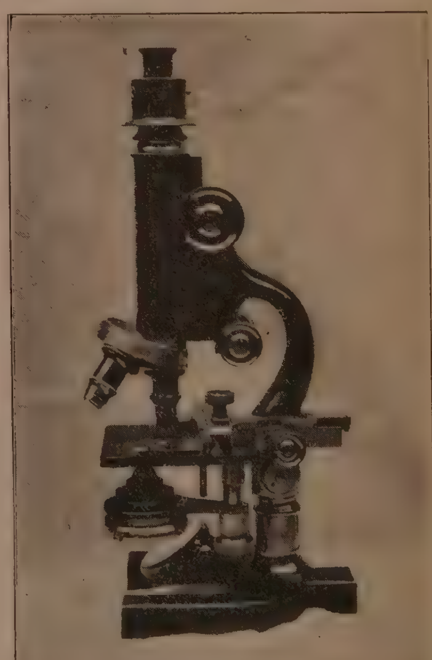
Dans un numéro précédent de cette revue, nous entretenions le lecteur de l'ultramicroscopie en faisant voir que l'utilisation d'un accessoire fort simple pouvant nous montrer des détails intéressants dans les objets translucides vus au microscope; aujourd'hui, nous parlerons d'une autre ressource que cet instrument est capable de nous fournir lorsque nous nous servons de la lumière polarisée.

La polarisation de la lumière peut augmenter de beaucoup l'efficacité d'un instrument dans les observations microscopiques. Nous achetens quelquefois à prix d'or certains accessoires qui coûtent beaucoup plus cher et qui sont bien moins utiles qu'un appareil à polarisation. Cela provient de ce que nous n'en connaissons pas l'utilité. Les traités de physique ou de microscopie donnent bien quelques notions générales sur les applications de cette intéressante propriété de la lumière, et, dans les institutions, les polariseurs et les analyseurs font plutot partie du musée que du matériel de laboratoire, cela quand on les possède, mais la chose est enconnue en pratique.

Le présent article a pour but de renseigner sur ce sujet les lecteurs qui ne sont pas famiiiers avec lui. Nous prierons les autres d'avoir de l'indulgence pour l'auteur qui n'a pas l'intention de donner la preuve scientifique de ce qu'il avance mais qui se contente de décrire simplement ce qu'il a vu dans son instrument au cours de son travail. Nous omettrons à dessein les longues explications parfois hypothétiques qui ont trait a la cristallisation des substances minérales, à la théorie vibratoire de la lumière, à son interférence et à différentes autres propriétés mises en jeu dans son application en microscopie parcequ'il est possible de les trouver dans les bons traités de physique. Ici, la théorie n'est pas nécessaire pour les applications courantes et nous prendrons l'appareil à polarisation, l'appliquerons à notre instrument sans demander comment il dirige les rayons lumineux ni quelle sorte de vibrations lumineuses il nous transmet. L'étendue de ce travail ne permet pas non plus de tout expliquer.

L'appareil à polarisation peut avoir différentes formes selon l'usage auquel il est destiné. En principe, il est formé de deu bouts de tubes dans lesquels on a inserti d prismes de spath d'Islande taillés suivant ce taines lois et soudés entre eux au beaume c Canada. L'un de des tubes reste fixe et nomme "polariseur", l'autre est mobile se nomme "analyseur" parceque c'est avec l que l'on recherche les effets de la lumiè polarisée en le faisant tourner sur son ax Les prismes qui servent à la polarisation so quelque fois appelés "Nicols" du nom de le inventeur.

La lumière qui passe à travers ces prism dans la direction de l'axe cylindrique leurs tubes subit des modifications varié selon la position rotative réciproque d'un ces tubes par rapport à l'autre Il est possib d'adapter des Nicols à n'importe quel micr scope composé qui porte un condensate Les instruments qui sont spécialement co struits pour les recherches chimiques minéralogiques portent leurs nicols d'u manière permanente mais sur les instrumen

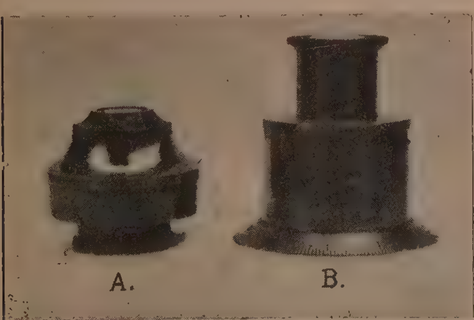


Microscope Stiassnie muni de l'appareil à polari tion. La fente pratiquee dans l'analyseur per l'introduction de la lame sensible. (Cl. O. Car

ordinaires, le polariseur a la forme d'un condensateur ordinaire dans la douille duquel il s'ajuste et l'analyseur prend celle d'un capuchon qui s'emboîte sur le tube porte-objectif. Les fabriques américaines vendent des appareils de $40.00 à $60.00 selen leur perfection mais il est actuellement possible de s'en procurer d'excellents en France ou en Allemagne pour le tiers et même le quart de ce prix. Il devrait aussi être économique de les faire fabriquer sur demande, en fournissant la mesure des parties sur lesquelles ils s'ajustent.

Mettons maintenant l'analyseur à la place du condensateur de notre microscope, coiffons en l'oculaire avec l'analyseur et observons ce qui se passe dans le champ visuel de l'instrument lorsqu'on fait tourner l'accessoire supérieur. Dans une certaine position de ce dernier, le champ se trouve presque complètement obscurci. Notons bien ce point pour y référer plus tard. Si à partir de ce point, nous faisons tourner l'accessoire supérieur, soit à droite, soit à gauche, le champ s'illuminera graduellement en donnant un maximum de clarité avec une rotation de 90 degrés, si l'on continue à tourner, le champ s'obscurcira de nouveau. A 180 degrés, il sera noir comme au début et si l'on continue à rotation, les mêmes phénomènes se reproduiront comme au premier demi-tour.

La polarisation de la lumière ne nous révèle pas la nature d'un objet mais elle nous dit simplement si un corps est monoréfringent ou biréfringent. Cette connaissance est cependant précieuse au minéralogiste ou au chimiste parcequ'elle nous aide à trouver les propriétés de certaines substances isomères comme les sucres et quelques acides organiques. Quand on dit "dextrose" et "lévulose", on ne fait qu'exprimer une propriété polarisante de ces sucres.



Les deux accessoires formant l'appareil à polarisation. A) Polariseur; B) Analyseur.

Lorsque les Nicols sont croisés, c'est-à-dire placés dans la position obscure et que l'on met sur la platine de l'instrument un corps possédant des propriétés biréfringentes, c'est-à-dire polarisantes, ce meme objet s'illumine tout à coup, c'est-à-dire qu'il apparait éclairé sur un fond noir, mais pas également dans toutes ses parties. Il y a des clairs, des demi teintes et des parties sombres dont la localisation peut changer de place lorsqu'on tourne l'anayseur modifiant amsi la clarté du champ au moyen de la même rotation. Les parties claires ou obscures d'une préparation peuvent même changer de place les unes avec les autres selon la position des Nicols.

Si maintenant l'on place entre l'analyseur et le polariseur une lame très mince de sélénite (sulfate de chaux cristallisé), de quartz ou de mica, il est possible de rendre cette différenciation encore plus intéressante. Cette pellicule porte le nom de lame sensible parcequ'elle traduit en couleurs variées les phénomènes que nous avons observés jusqu'ici dans le champ visuel du microscope. La lame sensible peut être placée soit dans un disque tournant en dessous de la platine, soit sur la platine elle même, soit dans une glissière pratiquée dans la monture de l'analyseur, immédiatement en dessous du Nicol. Dans ces deux derniers cas, elle épouse la forme d'une préparation microscopique que l'on peut se procurer chez les constructeurs. On peut en fabriquer soi même de très intéressantes avec des feuilles de mica comme celles qui se vendent pour les fenêtres des poeles. Ces dernières sont loin d'être parfaites mais elles peuvent devenir intéressantes à l'occasion parcequ'il est facile d'en confectionner une série de teintes différentes. Avec une lame de sélénite d'une épaisseur uniforme de 0.06 mm., la couleur principale est rouge lorsque l'analyseur est tourné dans la position obscure dont nous avons parlé plus haut, c'est-à-dire lorsque les Nicols sont croisés; la teinté est verte avec des Nicols parallèles (90 degrés), et jaunatre entre ces deux positions. Si l'épaisseur de la pellicult était de 0.08 mm., la teinte principale serait bleue, la teinte opposée serait orangée et ainsi de suite. On voit que la plus légère modification dans l'épaisseur de la pellicule a pour effet de changer toute la série des nuances. Les teintes peuvent encore varier dans un même appareil selon la source de lumière dont on se sert. Avec lame sensible, il faut

remarquer que les portions claires et obscures du champ microscopique se traduisent par des couleurs complémentères avec des nuances variables dans les positions intermédiaires de l'analyseur. Ainsi les noirs, les demi-clairs et les clairs que nous avons constatés précédemment se traduisent ici par des couleurs différentes. Il n'est pas toujours possible de provoquer telle ou telle couleur dans les différentes parties d'une même préparation par rapport au fond du champ ou aux couleurs voisines parcequ'on ne peut pas, dans la pratique, tenir compte des lois qui font varier leur gamme mais il est vrai de dire qu'en mettant convenablement les Nicols l'un par rapport à l'autre, il est possible d'obtenir des oppositions de couleurs fort intéressantes et parfoisfois démonstratives.

Nous avons vu que la polarisation ne pouvait pas nous renseigner sur la nature chimique cette propriété n'a rien à voir dans l'examen n'avait pour effet que de nous faire connaître la nature de la réfringence. Comme cette distinction ne s'applique regoureusement qu'aux corps qui cristallisent on serait tenté de croire que cette propriété n'arien à voir dans l'examen des tissus histologiques. Or il n'en est pas ainsi parcequ'un grand nombre de substances organisées jouissent plus ou moins du pouvoir polarisant malgré qu'il ait été impossible jusqu'ici de constater expérimentalement leur structure cristalline.

En histologie animale, il est très intéressant d'observer le tissu osseux, le tissu cartilagineux, les poils, les ongles ou autres parties cornées, les fibres musculaires striées, les noyaux des leucocytes et certains cristaux organiques. Avec la lame sensible on obtient des oppositions de couleurs fort intéressantes, à condition que ces tissus ne soient pas colorés avec des teintures.

Mais c'est surtout en histologie végétale que les teintes sont plus marquées parceque la densité des éléments différenciés est plus variable d'une partie à l'autre. Si la section qu'on observe n'est pas uniformément plane comme la chose arrive souvent dans les coupes à main levée, il ne faudra pas s'attendre à obtenir une couleur unique sur tous les éléments de même nature. C'est ainsi par exemple qu'on provoquant une teinte verte sur certains vaisseaux libériens, lorsque le fond du champ est rouge, tous les vaisseaux de même nature n'aurent pas absolument la même teinte. Si les faces de la coupe ne sont pas rigoureusement parallèles, la chose peut encore se produire avec des lames sensibles imparfaites comme celles que l'on confectionne soi-même.

Le tableau au-dessous donne une idée de la différenciation chromatique que l'en peut obtenir dans les différentes parties d'une même préparation. Dans tous les cas, le fond du champ est de teinte violette. S. L. et S. T. signifient respectivement: Section longitudinale et section transversale.

Ce phénémène de la différenciation des tissus par les couleurs de polarisation est peut-être plus agréable pour les yeux de l'observateur qu'utile pour les sciences biologiques, mais quand on songe à la somme de travail nécessaire pour confectionner une bonne préparation microscopique à double coloration, il est intéressant de savoir qu'il existe une méthode qui donne presque le même résultat d'une façon tout à fait mécanique en faisant simplement tourner un petit tube entre son pouce et son index.

Nous n'irons pas dire que le microscope polarisant a des chances de révolutionner la microscopie et qu'il pourra remplacer les méthodes actuelles de coloration. Il possède des qualités qui sont mal connues d'un grand nombre de travailleurs sérieux et peut rendre d'incontestables services aux professeurs d'institutions secondaires qui faute de compétence, d'outillage ou de ressources ne peuvent pas se servir des méthodes ordinaires de montage et pourraient tirer un excellent parti de ces phénomènes pour leurs explications.

	Bleu	Vert	Jaune	Rouge	Rose	Incolore ou Polychrome
S.T. Trifolium Pratense	Liber	Ecorce Moelle			Moelle	Bois
S.L. Chenopodium album		Fibres	Cristaux	Tissu	Vaisseaux	
Epiderme de Phalaris picta	Tissu		Vaisseaux	Stomates		Vaisseaux
S.L. Thuya		Aréoles		Tissu		
S.L. Os de boeuf	Canaux		Canaux	Tissu		Ostéoblastes

Prairie Problems in Entomology.*

E. H. STRICKLAND

Professor of Entomology, University of Alberta.

The major entomological problems in re-tion with grain production on the prairies iffer in some important respects from those iat have received the greatest attention in astern Canada.

The fruit growers and the market garden-s of Ontario have, to a large extent, come look upon the presence of insect pests as n unavoidable evil, though they have learn-l that by being on the alert with spray, dust some other form of poison, they are well ble to hold the majority of these pests un-er control. The most successful producers re, indeed, often in the field with their prayer before ever the insects appear in the pring because they know that their advent inevitable, and they have learned the full eaning of the old adage that an ounce of revention is worth a pound of cure.

Parasites or climatic conditions may, at mes, decimate some of the most injurious ests but these factors are too problematical or the grower to rely upon them in prefer-ice to adherence to the advice given to him his spraying calendar.

For this reason one finds that the main roblems of the eastern entomologist are to udy in the minutest detail the life-histories the various pests that attack the different ops, and to ascertain in what stage of their evelopment they can be the most economical- poisoned. This has been followed by a udy which is almost, if not quite, as inten-ve of various materials that may prove to more effective and economical than are the sect poisons which are now in general use. The results have been eminently satisfac-ry and there are few serious insect pests in stern Canada for which a suitable poison, id method for its application, have not been scovered.

When one makes a survey of the various sect pests that have received the most at-ntion in the East one cannot but be struck the fact that the majority are of foreign igin. Of the host of insect species that are itive to Canada few cause more than occasional damage. One need but cite a few of the most notorious pests of the East, such as the San José Scale, the Apple Psyllia, the Codling Moth, the Brown-tail and the Gipsy Moth of fruit trees, the Currant and Gooseberry Sawfly, the Onion Maggot, the Cabbage Butterfly and the Corn Borer, of market gardens, to convince oneself of the fact that the entomological problems of the East deal largely with undesirable aliens.

These foreign pests hail from many quarters of the globe and we can safely say that the majority of them gained admission to this continent with the importation of the plants to which they are now most injurious. We all realize today that the insect from overseas is liable to be our most serious menace because it so often leaves behind it the natural enemies which in the home country, prevented its undue increase. Heroic efforts have been made to establish in America the enemies of some of our most destructive immigrants, but many of these parasites cannot emulate their hosts in the matter of adapting themselves to our climate.

For this reason the judicious use of poisons to prevent an annual increase has become the generally accepted practice for the control of insect pests in the East.

At the time when the vast western prairies were being rapidly settled the study of entomological problems in Canada was still confined largely to the East. Every year brought with it improved methods of poisoning various insect pests. Even those that drew their nourishment entirely from the flowing sap of tree trunks, and were provided with a horny armour as a protection from their enemies were no longer immune from the poison warfare of man.

It was unnatural, therefore, that, when to the East flowed an ever increasing stream of enquiries from the newly settled West regarding means of controlling insects such as cutworms, and grasshoppers which were taking

* Paper read at the C.S.T.A. Convention, Edmonton, Alta., June, 1925.

a heavy toll from the vast acreage of wheat, the advice that returned advocated the use of poisons.

Indeed, a western entomologist, Mr. Norman Criddle, soon showed that, for one grain-infesting insect of the prairies at least, poisoned bait was a very effective remedy. From this observation have developed the vast grasshopper poisoning campaigns that the West has recently so successfully concluded. Such campaigns, however, necessitated the expenditure of sums of money that were far beyond the purse of the farmers who lived in the most severely infested districts and their successful prosecution was possible only by means of liberal, practically unrestricted, governmental aid. Far more money was spent in many a field than the crop returns will reimburse for several years, yet the expenditure was justified since every infested field that remained untreated constituted a menace to crops growing miles beyond its boundaries.

In this respect grasshoppers are unique among our major grain pests on the prairie. For them alone can we justify the extensive use of poisons.

It is of our other important pests that I particularly wish to speak, and this brings us to a consideration of the main difference between the problems of the prairie entomologist as compared with those of his confrère in the East.

These, as I see them are as follows:

1. The returns per acre from eastern orchards are many times those per acre on the prairie. Even were poisons 100% effective they could rarely be applied by a sufficiently economical method to justify our recommending them for the control of a generalized insect outbreak.

2. Where the eastern entomologist is combatting chiefly imported pests we on the prairie have imported nothing but the seed of our staple crop and have, therefore, largely escaped infection by insects that are foreign to Canada. We derive nearly all of our trouble from native insects whose increase is indirectly due to ourselves as agriculturists.

On the one hand we are unable to employ the methods that are so admirably suited to orchard conditions whereas on the other we may have at our command methods of reducing damage from our insect pests that are, to a large extent, denied the eastern worker.

The major problems of the prairie entomologist are two-fold. First he must discover by what agricultural practice an insect that never attained to large numbers in the days when the prairie was virgin sod has been given an opportunity to increase to overwhelming numbers. His second problem is to find some means whereby it may, if possible, be forced back to the place that it occupied before man disturbed the "balance of nature".

Only when a thorough knowledge of the first phase has been gained can any scientific attempt be made to realize the second. For this reason the prairie entomologist must be, above all, an ecologist.

The virgin prairie has supported for ages a vast complex of life competing with life and all of the animal life was dependent ultimately upon the native vegetation and the soil that produced it.

Among the competitors no battle was more fiercely fought than that between the insects. Of these "ten thousand" different species of insects every one was, and is, capable of prodigious reproduction. We can take the cutworm as an example. The female lays only about 300 eggs, and there is but one generation a year. A little calculation will show, however, that the progeny of a single female, if all survived, would be about two and a quarter millions at the beginning of the third year. Conversely, it follows that if this insect is to remain in approximately the same numbers from year to year the annual mortality, before reproduction, must be in the neighbourhood of 99.3%. Others of our native insects have far greater powers of increase than this.

Obviously, if any one species had ever been able to assert its reproductive ability to the full it could do so only by the extermination of its rivals. Since all of the species that dwelt here, however, were endowed with similar powers of multiplication an internecine warfare was inevitable.

Many insects here, as elsewhere, abandoned vegetation as an article of diet and gained their livelihood by preying upon their vege

arian relatives. They are limited in their ncrease only by the number of these relaives that they can attack. Conversely the increase of the plant-feeding species is held in check by the degree to which they are exposed to the depredations of their parasites.

As a result, no matter how prolific an insect may be, its annual numerical strength has remained comparatively stable, and despite the enormous potential for increase inherent to every species, an equilibrium has been established whereby those that are most exposed to their enemies are permanently less numerous than are some others which, though possibly less prolific, enjoy a greater immunity from attack.

The prairie then, may be considered as an immense battle-ground upon which an agelong competition had determined which should be the dominant species of insects and which should eke out a bare existence from year to year.

With the introduction of agriculture the whole face of the battle-ground has been altered. Vast stretches of what was once hard sod-bearing soil have now been transformed into mellow fields upon which are growing a vegetation that is foreign to the country.

Is it to be wondered that such a fundamental modification of the entire environment has given some of our thousands of different species of insects an opportunity the better to escape from their enemies or to compete with their rivals?

The Pale Western Cutworm, which is one of our most destructive pests, is a good example of an insect whose increase is the direct result of agricultural practices.

In the days when Alberta was still the home of the rancher there were among her scattered population a number of keen-eyed entomologists who devoted much of their spare time to capturing and classifying the butterflies and moths that abounded on the plains. By their industry all of the commoner species were soon catalogued and they then engaged in a friendly rivalry to capture and to record the rarer forms. Amongst these few were less frequently taken than the extremely scarce greenish moth, *Porosagrotis orthogonia,* the adult of what is now known as the devastating Pale Western Cutworm.

To-day if a trap-lantern be placed in a field in the late summer as many as two thousand of these moths may fly to the light between sunset and sunrise, and similar catches may be made nightly for a period of several weeks.

Many a farmer has seen an entire field of wheat, perhaps of a hundred acres or more, become patchy in the middle of May and in less than a week the ground become as bare as if it never had been seeded. In the soil of such a field can be found vast numbers of the grey cutworms that are the progeny of the once scarce moth.

We have long since learned to our cost that any attempt to poison this pest is impractical. How then are we to cope with the situation? Our first problem is to ascertain the cause of their phenomenal increase. This calls for a detailed study, not only of the habits of the insect, but of its entire environment. We must ascertain what are the effects of our artificial modifications of the soil and the vegetation upon its activities, and also upon the insects with which it is associated, particularly those which are its parasites.

We now know that the moth lays its eggs only in the soil and furthermore that it selects for this purpose only such soil as has a loose, dusty surface, beneath which the eggs lie unmolested during the winter. In the spring the small cutworm remains permanently below ground, provided the soil is loose enough for it to move freely in it from plant to plant. If the soil be hard, such as it is on the unbroken prairie, the cutworm must come to the surface in search of food. Good oviposition sites are, however, scarce on the prairie and few moths now lay their eggs in any but cultivated fields, where in suitable seasons very few cutworms ever come to the surface.

Herein lies the cause of cutworm increase. They have many natural enemies but, with few exceptions, these are powerless to attack unless their prey moves on the surface of the soil. The methods of attack are often indirect but the failure of the erstwhile dominant parasites can be traced in every instance to agricultural practices.

Armed with a knowledge of the effects of these practices, not only upon the cutworm but also upon its major enemies, our efforts

must be to find some modification in our methods of cultivation that will be less detrimental to the parasites, since it is on them that the problem is now focussed. They still are, as they always have been, the most economical and effective agency for holding cutworms in check. For a time we have curtailed their powers to our own detriment. Once we can restore them the cutworm problem will be solved for all time.

In recent years the Wheat-stem Sawfly has caused great losses over a large acreage on the prairies. Here again the problem is one of ecology, though how we can undo the harm that has been done by the introduction of a foreign plant to the flora of the prairie is, at present beyond our knowledge.

An ever-increasing menace to the grain-grower is the wireworm. Contrary to general belief the species that are most destructive in Alberta do not thrive best in sod. Their increase is due to the conversion of prairie sod into grain fields. In this instance the controlling factor in days of yore was not, it appears, other insects. By cultivation we have not allowed this prolific, yet not over-successful dweller of the plains, to escape from the enemies that formerly held it in check. Yet here, once more, we must face the fact that by our agricultural methods we have allowed an undue increase, and that in a modification of these methods lies our salvation from this pest.

These are examples of the most pressing problems of the prairie entomologist, and they are not easy of solution. I hope that they will indicate to you the difference in emphasis that is necessary in the training of an entomologist whose field of activity is confined to the prairie as compared with those of one whose work lies in the East.

While it is essential that an entomologist, wherever he be stationed, have a working knowledge of his subject in all of its phases his period of training in college or university is so short that he cannot be a specialist in all, and in the solution of western problems a thorough grounding in ecology is of infinitely more value than is a detailed knowledge of the vast array of facts that deal with the control of insects by the use of poisons.

FEDERAL ADVERTISING

The attention of profession agriculturists is directed particularly to the two pages of advertising appearing in this issue, inside of the back cover. This advertising has been prepared and distributed by the Dominion Department of Agriculture in an effort to enlist support and co-operation in widening the markets and increasing the demand for Canadian agricultural products. Too few of our farmers realize the importance to the country, and the financial benefits to themselves, of the grading regulations which are now in effect in this country, and too few of our professional agriculturists are spreading the new gospel.

At the recent meetings of the Imperial Economic Committee, held in London, England, an earnest effort was made to devise ways and means of increasing the consumption of colonial products in the home market. The deliberations of this Committee, on which Canada had two representatives, extended over several weeks. Many recommendations were made, the chief of which were (1) that the colonies should carry on, almost continuously, an educational campaign with the object of improving the quality of their agricultural products, especially those destined for consumption in Great Britain and (2) that, so far as possible, facilities be provided to ensure a steady supply of high quality products for the British consumer.

The professional agriculturists of Canada, those engaged in extension work, in teaching and in administration, can do much to assist in this campaign. They are the men to whom the farmers look for advice, and when an economic problem so important and so vast in its possibilities, is facing the country, these men should not sit back. They should do all in their power to minimize any criticism of grading laws and educate the farmers to a real appreciation of the economic factors involved.

Agricultural Engineering and Its Place in Canadian Agriculture.

L. G. HEIMPEL

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To date the voice of the Engineering branch f Professional Agriculture in Canada has een conspicuous by its absence. Neither at ur conventions nor in the pages of the Jour-al have we had much to say. Yet it is easonable to suppose that if engineering is have a place at the round table of profes-ional agriculture in Canada the initial ac-on at least should be taken by the members f that particular branch. Except for a few chnical articles nothing of an engineering ature has appeared in the pages of the Jour-al since its first number. Strictly technical rticles, whether dealing, for instance, with a ew invention in connection with the knotter f a grain binder or with a new method of reparing bacteria for the microscope, never ppeal to an exceedingly large number of eaders. It is, however, not the intention of is article to be technical, but to place before ur membership the "case" of the Agricul-ıral Engineer in Canada.

Among the branches of Professional Agri-ılture, in our Colleges from coast to coast, our governmental departments of Agricul-ıre, both federal and provincial, and in the nounts of money spent to forward our var-us messages to the student and to the farm-, we are one of the "little sisters" if not e "weak sister". True, in the majority of ır colleges there is an "Agricultural Engin-ring Department" headed by a professor, ıt in several instances engineering work is oken up between departments of physics ıd the farm mechanics branches of the in-itutions. With the exception of some drain-e extension in Eastern Canada and a little tension work of a more or less desultory ıture in the West most of our provincial vernments spend practically no money in ricultural engineering extension work. The ominion Department of Agriculture and the cperimental Farms' System have thus far ne little toward establishing engineering a separate branch of their activities. This, in a few words represents the status of engin-eering in our agricultural educational pro-gramme to-day.

All this is indicative of nothing so much as of the fact that engineering in professional agriculture is a very new branch, and our hope is that, as time goes on, the importance of this branch and the immensity of its field of work will become very real to those who are responsible for agricultural educational policies throughout our Dominion.

The Growth of Agricultural Engineering

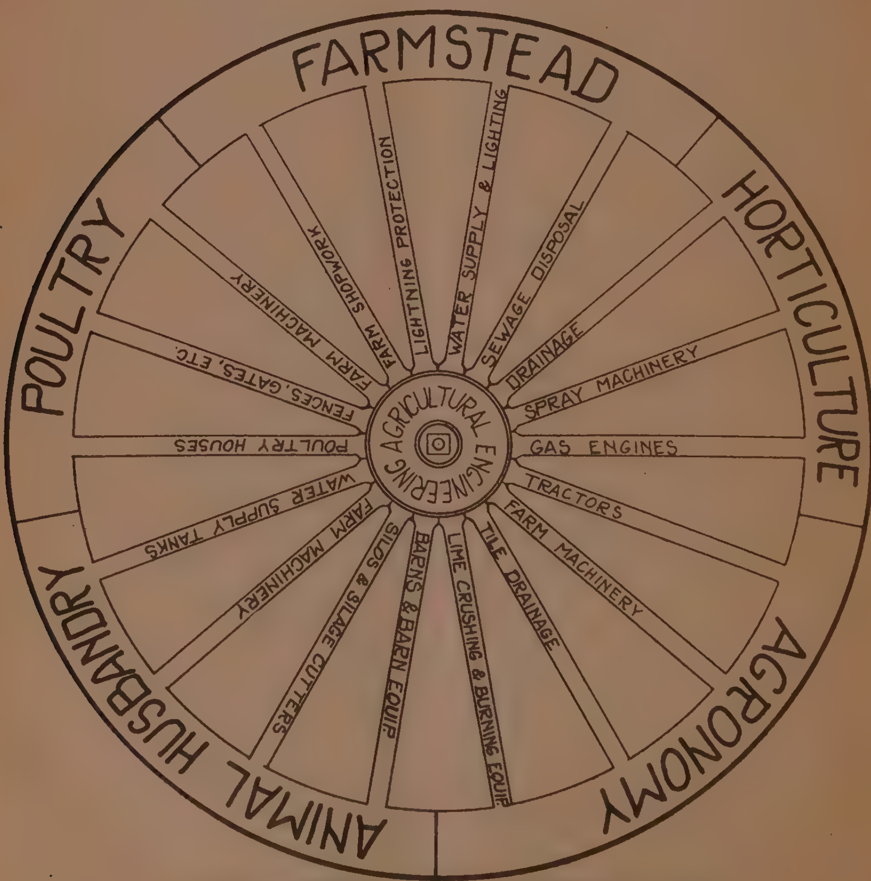
One of the strongest indications of the soundness of our agricultural policies is the fact that in the past few innovations have been introduced until the time for their in-troduction was due, and not infrequently, overdue. In the early history of our older agricultural colleges there were few engineer-ing problems. Land was cheap and timber cheaper. Labor could not readily be sold off the farm, therefore there was no necessity to consider cost of equipment and cost of production as vital factors among the farm-er's problems. Livestock improvement and the development of varieties of field crops of higher yield, better quality and of greater suitability to our climatic conditions were, in those days, factors of primary importance and constituted the major portion of the educa-tional and experimental activities of the time.

During the last twenty-five years, however, forces influencing the methods and costs of agricultural production have undergone tre-mendous changes. Spare man-hours have al-ways found a ready market, causing the farm-er to compete with the cities, the railroads and, of late, the road-builder in the matter of hired labor; land is no longer one of the "free" commodities in agricultural produc-tion—far from it—and latterly, even within the last ten years, the value of lumber and

timber, our national building material, has risen to staggering proportions. These are a few of the circumstances which have been responsible for the introduction of the engineering profession into agriculture.

In the United States farming has passed through stages similar to those through which we are now passing. Crises calling for engineering assistance came in the same way as they are coming to us and it is interesting to note how they are being met. Practically all colleges in the States to the south of us have strong agricultural engineering departments, Cornell having seven A.E. professors. Most of these colleges have been offering specialist's courses in Engineering for the B.S.A. degree, many of them are offering post graduate work in it, and one, Iowa State College offers a special degree, that of A.E. which is considered the equal in every respect of M.E. and C.E. from the same institution.

In extension work as well, Agricultural Engineering has fast come into prominence, most of the states carrying on fairly heavy programmes in this branch of extension activity. For instance, the doubled and redoubled cost of building construction which is just becoming so serious here has long been felt in the U.S. and as a result, the most economical way of overcoming this circumstance has for some years been one of the major features in the field of agricultural engineering education, research and extension. Another agricultural problem which is attracting much attention throughout the United States, but of which we have only the merest hints at the present time, is that of soil washing. It is only a matter of time when dire necessity will cause us to



THE WHEEL OF AGRICULTURE
AFTER WHEELER.

face this problem in our own land. Underdrainage forms one of the most valuable branches of extension in most of the States, while Drainage District organization has been carried very successfully in many of them. Campaigns to improve water supplies and sanitary condition and to promote the more efficient use of labor and equipment are now regular features on their extension programmes. Wherever engineering extension work is attempted it meets with interested response. As shown by the accompanying chart the engineer finds his work in every type of farming, and he will attract a larger percentage of the people of a given community than will perhaps the work of any other single department of our colleges.

No doubt there has been very creditable growth in the field of agricultural engineering in Canada, but it seems to us that in the last few years it has not received the attention of which it is worthy. As an instance let us cite again the need for research and education along the lines of building construction. We know that the timber frame barn costs 25 per cent more for lumber and over 30 per cent more in carpenters' wages than does the modern plank frame type of barn. It is also true that in Ontario barns are often much larger than the business can afford, while in Quebec thousands are woefully inefficient in design, and throughout the whole of Canada stable sanitation is usually never thought of, yet we have never met a man stumping the country districts "selling" farmers on these facts. While this new branch of professional agriculture is fairly well established in our colleges, it has not reached this position in the Dominion Department and our provincial Departments of Agriculture.

Agricultural Engineering and Agricultural Economics

To many of our professional agriculturists the term "agricultural engineering" means farm mechanics and the mention of it brings to mind a few scattered lessons in the rudiments of mechanical drawing, a little woodwork, a little blacksmithing and perhaps a little farm machinery. Farm mechanics is, however, only one of the divisions of our field and, if we were asked to define its limits, we would say that under "agricultural engineering" must be included, "The design, construction and use of all equipment, structural and mechanical, in connection with agriculture." The moment we begin to consider this definition the close relationship between engineering and economics in agriculture becomes apparent. No two branches of agriculture are more closely related to-day than are engineering in agriculture and farm practice.

During the hard times, which we try to believe are about over, there seemed to be abroad an idea that the agricultural engineer was one person whose dreams must be "soft pedaled". They were looked upon as a tribe advising extensive equipment purchases, especially "costly tractors" and such "luxuries" as bath room equipment and automobiles. No conception of our objectives could, however, be farther from the truth. While it is true we believe in the application of more mechanical power and machinery to agriculture, the stipulation "whenever it can be made to pay" is always in our minds. We consider that the agricultural engineer's most important problem to-day is to bring about an increase in efficiency in agricultural production or, in other words, to pull down the fixed charges or "overhead" connected with the industry.

The table below, taken from the data of a recent survey of farm business, conduct-

	Average		Most Porfitable Farms		Least Profitable Farms	
Capital	$	%	$	%	$	%
Total capital	10,652	100	12,247	100	13,311	100
Real Estate	8,746	82	9,956	81.2	11,287	84.7
Buildings alone	2,286	21.4	2,447	19.9	2,724	20.4
Machinery	650	6	737	6	692	5.2
Livestock	1,279	12	1,554	12.6	1,331	9.9

NOTE—Under "real estate" is included both land and buildings.

ed by S. J. Chagnon, B.S.A., Central Experimental Farm and covering the business of 400 typical Quebec farms, shows the distribution of capital in the farming business in that province. In a general way this distribution does not vary very much throughout the Dominion.

It will be noticed from this table that on the average farm 12 per cent of the total capital is invested in livestock, 21.4 per cent in buildings, 6 per cent in machinery, 60.6 per cent in land. The interest on the enormous amount invested in land, buildings and machinery comprise the source of "overhead" or "fixed charges" in agriculture and it is doubtful whether the 21.4 percent for buildings is anywhere near high enough to cover present day replacement costs. These fixed charges must all be met by money made out of crops and livestock. At the same time we expect to see a profit at the end of each year's operations. This profit is just as real, just as efficient and just as welcome if secured by paring the overhead charges as it is when due to an increased income through higher prices or larger yields. Owing to the unequal distribution of our investments between what might be termed 'positive' and 'negative' sides of our business, it is plain that a reduction of one per cent in our "negative" investment is the same as an increase in revenue equal to seven per cent on our total livestock investment. We believe that, under present circumstances, it is tremendously less difficult to increase our profits by reducing our costs of production by a small percentage than it is to secure a similar profit waiting or fighting for higher prices or by throwing all our energies toward improvement of quality and yield in our various products. This conviction is based upon the very fact that, for many years, we have been exceedingly zealous, almost to the point of being lavish, to increase the quality and yield of our crops and livestock. Costs of production and the means of keeping it down have however, found very little place on our extension programme. To produce in greater quantity without increasing our overhead pro-rata is the greatest need of Canadian agriculture to-day. To increase profits solely by means of higher prices, whether secured through co-operative marketing or any other manner encourages inefficiency while to concentrat on reduction of overhead charges as a sourc of profits places a premium on efficiency. I is in this phase of agricultural education an extension that the engineer is more particula ly interested.

To increase the efficiency of our instr ments of production is equivalent to a lov ering of our overhead charges. The eng ineer's field in connection with the more eff cient employment of our land, labor, source of power and equipment has hardly bee touched. The following are only a few c the means through which much can be a complished—(1) The provision of adequat drainage in the provinces of humid climat Thousands of square miles in the St. Law rence Valley are being farmed at very lo profit and very often at a loss due to th lack of drainage. Similar conditions pre vail in large parts of most of our provinces

2, Re-planning and re-fencing of farms s as to make fields of sizes most efficient from the standpoints of tillage costs, convenienc for crop rotation and economy of fencing.

3, More complete clearing of our farr lands. In the older districts of Eastern Can ada there are thousands of miles of farr fence lines along which have sprung up al most impenetrable growths of scrub elm an other forest trees accompanied by hawthorn and other low growing trees and shrubs These growths sap the plant food of the soi for several rods on either side of the fences robbing the crops. They harbor injuriou insects which make these fence rows thei breeding ground and hibernating residenc making the control of insect pests almost im possible. They cast objectionable shade o growing crops, provide a place for the growt of noxious and poisonous weeds, and owin to the neglected appearance they give to farm, reduce its market value.

Boulders, small ravines, unnecessary ope ditches and other obstructions waste tim cause damage to machinery, decrease cro areas and in other ways tend to lessen th efficiency of the land on thousands of farm where they are allowed to repose from yea to year. In the majority of cases wher these conditions are found these things coul be remedied and the efficiency increased co

siderably without any cash outlay whatever. Without an extension campaign of a convincing nature, however, they will not be removed.

4, The problem of securing lime for counteracting acidity in soils at reasonable cost is largely one for the engineer. High freight rates make its cost prohibitive even where the haul is comparatively short. Where limestone is available crushing or burning it on or near the farm is cheaper than shipping it in, provided that economical equipment and methods of operation are employed.

5, Improvements in tillage practices. Much remains to be done towards the securing of reliable data on the suitability of the various kinds of tillage machinery for the various tillage operations. Subsoiling as an aid to natural and tile drainage could, we believe, be practiced with considerable profit on our lands of heavy subsoils and poor natural drainage.

6, Much is possible in the way of increasing the efficiency of human labor on our farms. It may be accomplished by the use of larger units of power and machinery, as for instance the use of the two furrow plow where now single furrows are drawn. It may be necessary to thresh from the field instead of stacking or mowing away grain, or it may even mean the introduction of mechanical curing of our crops. By planning our cropping systems so as to distribute the work more evenly over the greatest possible portion of the year, thus preventing, to some degree at least, the familiar "rush-seasons" which now form the peak loads of our labor bills, much can be done to make more efficient use of our human labor. If more attention were paid to planning for convenience, both in the location of buildings in the group, and in their interior arrangements, hundreds of man hours and miles of walking could be saved each year. This applies to houses as well as to barns and stables. It is a peculiar fact that labor saving machinery which is useful 365 days of the year is not nearly so common as the machines which are used perhaps only ten days. The former can do as much to increase our production per man as can the latter and at the same time greatly lessen the daily drudgery of the farm, yet it is in "chore reducing machinery" that we are short.

7, Increasing the efficiency of our farm equipment, is, for the moment, perhaps the field most urgently in need of the agricultural engineer's attention. When we come to the point where farm buildings must be replaced we simply must be satisfied with smaller houses and barns. It is possible, we believe, to meet this demand without compromising the efficiency of our methods of farm practise nor need it result in subjection to inconvenience. It is likely, though, that we will be forced to use to better advantage the available capacity of our buildings, and, when new buildings are needed economy of cost of construction and efficiency of design must be given first place.

The judicious and more efficient use of mechanical power, not only with the idea of providing more comfort, though this is commendable, but that through its use we may deliberately apply the time saved to increase our production per capita is another worth while project. The application of electricity to agriculture, not only for lighting, pumping water, grinding feed, threshing and other familiar belt work, but in a hundred other ways not now thought of, permitting us to use electric current advantageously in sufficient quantities to enable power companies to sell it to us at prices making its use profitable, is a field providing several generations of agricultural engineers with a life work.

The more efficient use of farm implements and machinery is a crying need today. Machinery is the thing that has made farming what it is on the American continent. Yet in spite of its blessings we are losing millions of dollars each year through unwise and unnecessary purchases, through rust and weathering, through the discarding of "young machines", merely in need of repair, for new and expensive machines of the same sort, through poor quality of work and wastage of power due to the faulty choice of machines for the work in hand, through slovenly operation and through the poor mechanical condition of much of the machinery in use on our farms today. This condition can be remedied only by consistent educational and extension ef-

fort. There is, however, no such work under way at the present time.

With such a field of possibilities confronting us, are we wrong in believing that the farmer's economic troubles can be helped fully as much by extension effort and education along these lines as is possible through our present live-stock and farm crop concentration, worthy and necessary though this may be?

Farmer's Comfort Worthy of Engineer's Efforts

Thus far the dominating note in this article has been a cry for more and greater efficiency. It is possible, however, to overdo even a good thing. If coal miners, brick layers and other city tradesmen are entitled to a good living by working eight hours a day in addition to an hour or so spent in a tram car going to and from their work, there is no reason why we should forever continue to shorten our lives by overworking ourselves from fourteen to sixteen hours a day. If every hour lopped off our daily programme by machinery is immediately utilized to expand the volume of our business and hence our work, then we become slaves to efficiency and it may become a hateful word. We believe that part of the time more efficient methods and machinery can save for us should be devoted to the production of at least a little leisure for ourselves. Thousands of farmers have absolutely no time for even the thorough reading of one farm weekly of respectable size. Many are carrying on, single handedly, a programme of farming which, a few years ago, occupied the full time of two men. Their experience is not quite equal to the task of coping with the problem of rearranging their business to suit present day conditions and they carry on as well as possible along the customary lines. These circumstances are shortening the lives of thousands of our men and of our farm women.

The introduction of comfort producing and labor saving conveniences of the household, running water, lights and other electrical devices, sewage disposal and scientifically planned "workshops" for the farm house-wife is worthy of much greater support than it is receiving. These items should not be looked upon as "expenditures" but as "investments" in our business, not as luxuries but as conveniences to which we are entitled and which our business really owes us.

Such, then, is the field of the agricultural engineer. It is not enough that he be on hand to teach in our colleges, the art of blacksmithing or the construction of a tile drain. He has an indisputable connection with the largest and most vital issues confronting agriculture. What the mining engineer is to the mining industry and what the chemical engineer is to that industry the agricultural engnieer must be to Canadian agriculture.

The Significance of Chromosome Studies in Fruit Breeding.

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Most of our commercial varieties of fruits e chance seedlings. Improvement by sysmatic breeding has unquestionably been mpered by the paucity of inheritance studs in fruits. Concurrently, little improveent has been made in the methods of attack. d of procedure, used over a century ago in ple and strawberry breeding by such hortilturists as Thomas Andrew Knight and Chars Mason Hovey. The nature of fruits, parcularly the tree fruits, has not been especial- favorable for studies of heredity. Hower, a better understanding of heredity in uits may be secured by consideration of the dies concerned in the transmission and inraction of genetic factors, viz., the chromomes.

The chromosome theory of heredity was roposed shortly after the discovery of romosomes in plants 50 years ago. Early udies of chromosomes dealt principally with scriptions of equational and reduction divions from the "pure science" viewpoint. Of te years, however, investigators have recogized the practical utility of chromosome udies in breeding work.

Chromosome Numbers in Fruits

Chromosome studies have been conducted a relatively limited extent in economic uits. Investigations dealing with the causes sterility in a number of fruits have led some cases to determination of chromome numbers. The following haploid numrs of chromosomes have been found in uits: J. H. Hale peach—8, (Knowlton); lum—10, (Dorsey); grape—20, (Dorsey); rawberry—26, (Valleau); blackberry and spberry—7, 14, 21 (Longley; Longley and arrow).

In crosses between species with different mbers of chromosomes it is obvious that , for example, the peach with 8 chromomes is fertilized by plum pollen having 10 chromosomes, or vice versa, there will be irregularities when the two sets of chromosomes meet and particularly when the chromosome number is reduced at the time of gamete formation in the hybrid. The abnormal conditions which result in the nuclei on the union of gametes with different numbers of chromosomes is associated with sterility in a number of species and variety crosses.

Multiples of a Basic Chromosome Number

A matter of considerable interest at the present time in one of multiples of a basic chromosome number in the species of a genus. The origin of new forms may be accounted for in part by a doubling, tripling, etc., of the basic number. A few examples of multiple series of chromosomes in different species of the same genus will serve to illustrate the condition:

Leguminosae	6, 12,	or	24	pairs
Triticum	7, 14,	"	21	"
Avena	7, 14,	"	21	"
Rosa	7, 14,	"	21	"
Rubus	7, 14,	"	21	"
Crataegus	8, 16,	"	24	"

It is also possible that instead of the 26 haploid chromosomes as determined for the strawberry by Valleau the number may be 24 or 28, and that a basic number of 6, 7, or 8 will be found for Fragaria.

The subject of an increase of chromosome numbers may be considered as a chromosomal aberration type of mutation. No statement has been found to the effect that varieties of apples may have, or may be, originated through chromosomal aberration. Any evidence that new varieties of apples may arise through mutation of this sort would seem to be of interest and value in fruit breeding.

Origin of Apple Varieties

The common apples and crab apples are generally supposed to have come from two

original sources. All the common apples according to Bailey (Cyclopaedia) are modifications of *Pyrus malus* Linn., and the true crab apples are derived chiefly from *Pyrus baccata,* the small fruited Siberian crab. The large fruited crab apples such as Hyslop are said to be hybrids of *P. malus* and *P. baccata.* In regard to derivation of varieties from *P. malus,* Bailey states that some authorities consider there are two original species and that the common promological apple represents a welding of them through hybridization. With the exception of the crabs, however, all our common apples are placed botanically in one species, *P. malus.* Although *P. malus* is traced historically in the literature to remote antiquity, because of the manner of, and difference in, chromosome behaviour in Delicious and Stayman Winesap the question arises as to the possibility of some of our common apples having arisen from the original species by means of hybridization between species, or by mutation.

As a Ph.D. thesis problem* the writer studied chromosome behaviour in the pollen of the apple. Investigation was made of pollen development in Delicious, a variety selected to represent the normal, and in members of the Winesap group, where almost complete self- and inter-sterility, a considerable degree of cross-sterility, and low percentage of germination of pollen has been found by a number of investigators.

The number of chromosomes. 14, found in Delicious possibly indicate a multiple of a basic number, 7. In Stayman Winesap, chromosome irregularities during pollen development seem almost to be the rule. In the pollen mother cells of this variety both bivalent and univalent chromosomes are found. The bivalents, of course, are homologous while the univalents are not. Univalents are single or unpaired chromosomes. The reason such chromosomes do not pair is sometimes expressed as being due to incompatability or lack of affinity with the others. Univalent chromosomes have not been observed in the pollen mother cells of Delicious. Because of the presence of both bivalents and univalents in Stayman Winesap more individual chromosomes are apparent cytologically at the time of reduction division in this variety than in Delicious. The occurrence of both bivalents and univalents in Stayman Winesap probably indicates that two quite different sets of chromosomes have entered into the nuclear constitution of this variety. Where they came from is a matter of conjecture.

On tracing back the history of Stayman Winesap it is found in Beach "The Apples of New York" that this variety originated from seed of Winesap in 1866 at Leavenworth, Kansas, and bore its first fruit in 1875. In regard to Winesap, Beach states that nothing definite is known of its origin. Unfortunately, therefore, the history of the origin of Winesap and consequently of its seedlings, and in fact of most varieties, is veiled in obscurity. However, the evidences of irregular chromosome behaviour found in Stayman Winesap are suggestive of its manner of origin.

It is perhaps of significance to note that in many plants where irregular chromosome distribution has been found the phenomenon of polyploidy occurs. Abnormalities found in the pollen of Stayman Winesap, viz., sterility, irregular chromosome distribution, polyspory or extra microspores within the pollen mother cell wall, and polycary or the presence of miniature nuclei in the cytoplasm of the microspore, are characteristics of forms in which there is a doubling, tripling, etc., of a basic number of chromosomes. Reasoning from analogy it might be supposed that Stayman Winesap is an example of a polyploid form of apple. However, such conditions may also be the result of hybridity. In Delicious the haploid number of chromosomes is 14, while in Stayman Winesap the number varies in individual pollen grains. While the evidence is not sufficient to warrant definite conclusions concerning the manner of origin of Delicious and Stayman Winesap it furnishes an insight into the possibilities of polyploid forms of apples arising through mutation or hybridization.

Value of Chromosome Studies

The crab-like characteristics and hardiness of the first generation of crosses between standard and crab apples are well known. In

* To be published in the Botanical Gazette as a Paper of the Journal Series of the Minnesota Agricultural Experiment Station.

later generations seedlings are obtained which more closely approach the standard parent in tenderness and in size and quality of fruit. It would be interesting to know whether the number of chromosomes in *P. baccata*, and other pure species and hybrid crabs, is the same as in our standard apple varieties, and if not, whether the segregating generations of such a cross tend to approach the chromosome conditions as well as the external characters of the standard parent. The fact that doubling, tripling, etc., of a basic number of chromosomes occurs in so many forms suggests that similar conditions may be found in our economic fruits. It should not be a difficult task to ascertain the number of chromosomes in the root tips and pollen mother cells of various species and varieties of apples. Such information might then be of use in the selection of parents for systematic breeding purposes.

If it be established that chromosome sets of, say 7, 14, and 21 pairs exist in different species of apple, the breeding work could then be attacked from a viewpoint which so far has been given very little attention. Cereal breeders have encountered this problem in experiments to secure a rust resistant variety of wheat. If similar conditions were found to apply, for example, to the resistance of apple varieties to fire blight, such knowledge would then be of great importance to the fruit breeder.

Chromosome studies seem to be of significance in fruit breeding from at least two standpoints: (a)—to obtain a better understanding of certain difficulties in securing set of fruit, and (b)—to assist in selecting parents and in obtaining desired improvement of various fruits.

Co-operative Experiments with Farm Crops.*

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Science has made some wonderful advancements within the past century. Canada is first and foremost an Agricultural country. The best application of the principles of science to the practice of Agriculture is one of Canada's greatest problems. It demands the closest co-operation between our best educated men and our sincerest practical farmers. The Canadian Society of Technical Agriculturists has a wonderful opportunity of assisting in this great work if it possesses the true vision of the life and the work of the men and the women on the individual farms throughout this great Dominion.

May it keep a wholesome watchfulness that agricultural education be kept in close touch with Agriculture, that experimentation and research receive adequate support and encouragement, that agricultural laws and Agricultural Associations be as free as possible from complexities, inconsistencies and unnecessary technicalities and above all may it always form a truly helpful medium between the scientific workers and the practical farmers.

Progressive farming is necessarily a perpetual trying of experiments. The most successful farmers are those who experiment themselves most industriously, most skilfully and most intelligently. The Canadian people in rural life are largely noted for physical strength, mental power and moral stability. In the Province of Ontario, Agricultural teachers and scientific investigators have been co-operating with thousands of practical farmers in carrying out on their individual farms a carefully thought out and progressive system of definite experiments, along various lines of agriculture for the improvement of farm practice and for the elevation of farm life. The speaker has been closely identified with this work since he first persuaded a dozen farmers to conduct co-operative experiments on their own farms forty years ago. In 1925 the number of co-operative farmers has increased over the first small group by more than two hundred fold. The development of

* An address at the C.S.T.A. Convention, Edmonton, June, 1925.

this whole co-operative experimental scheme is of intense interest and has several features which are unique.

In Canada the first government experimental farm was established at Guelph, Ontario, in 1874 and in the United States the first agricultural experiment station was started at Middleton, Connecticut in 1875.

In 1879 the officers, ex-students, and students of the Ontario Agricultural College formed themselves into an association under the name of the "Ontario Agricultural and Experimental Union." The objects of the association were "to form a bond of union among the officers and students, past and present, of the Ontario Agricultural College and Experimental Farm; to promote their intercourse with the view of mutual information; to discuss subjects bearing on the wide field of agriculture with its allied sciences and arts; to hear papers and addresses delivered by competent parties, and to meet at least once annually at the Ontario Agricultural College."

At the beginning of the year 1886 experiments had been carried on at the College for a period of eleven years. The information thus obtained formed an excellent basis for the commencement of a system of co-operative experiments by the farmers of Ontario. There was no way in which this could be brought about better than through the medium of the Experimental Union, which was comprised of energetic young men who had had the advantage of the training at an agricultural college and had become somewhat familiar with accurate methods of conducting experimental work. The co-operative work thus started in 1886 which was confined in the beginning to farm crops has been developed by adding from time to time other branches of agriculture. In 1925 the co-operative experiments include work in ten separate departments which is the largest number in the history of the organization. Each branch of work is under the supervision of a committee, one of whom in each case is known as the director. In the present year, the ten committees have charge of co-operative experimental work in the departments of Field Husbandry, Agricultural Botany, Forestry, Agricultural Chemistry, Apiculture, Farm Literature, Agricultural Physics, Bacteriology, Animal Husbandry and Horticulture. The committees are appointed annually and some of them have been carrying on the work for many years, while others have started more recently. Each committee reports the results of the year's co-operative work at the end of each season with the exception of the committee in Agricultural Botany which reports each two years and the one in Forestry which reports every four or five years.

The co-operative experimental work is operated conjointly by the Ontario Agricultural College Experiment Station and the Ontario Agricultural and Experimental Union. The great bulk of the co-operative experiments are conducted by the farmers themselves upon their own farms. Some of them, however, are conducted by seedsmen on their trial grounds, by agricultural editors on the demonstration farms, by secretaries of agricultural societies on the fair grounds, and by public and high school teachers in the school gardens. The co-operative experiments when conducted on private farms as well as in more public places are frequently used as object lessons and are viewed by scores, sometimes by hundreds and in some instances even by thousands of visitors.

In the spring of each year circulars outlining the co-operative work are distributed by the various committees appointed by the Experimental Union. Those asked to take part in the scheme of co-operation may be classified as follows:—

1. The officers and students, past and present of the Ontario Agricultural College who pay an annual fee of fifty cents, and who have control of the executive work of the Experimental Union.

2. The experimenters of former years who have done satisfactory work.

3. Leading farmers, gardeners and others whose names have been suggested by Agricultural Societies, Farmers' Clubs, Principals of Collegiate Institutes, Inspectors of Public Schools and others.

4. Various persons who have seen the experiments of other people, who have read of the work through the public press or who have in some way heard of the experiments and who wish to assist in the movement by conducting experiments on their own farms

No direct financial help is offered any person to undertake and carry through the co-operative work. It is purely a volunteer movement from the start to the finish. Materials for the experiments, the instructions for making the test and the blank forms for reporting the results are furnished, free of charge, to those who ask to join in the work and who sign the agreement furnished by the Union. The experimenters with farm crops use the soil on their own farms, conduct the experiments themselves and report the results to the director. The crops produced are retained by the experimenters as their personal property with the exception of any small quantities which are returned to the College as samples.

From the beginning the co-operative experimental work has been directed and controlled by circulars and letters printed and written which have been transmitted through the mails. When personal visits have been made to the experimenter the object has been to enable the director to study the difficulties of those actually engaged in the work and thus be in a better position to know the best methods to adopt in the printed instructions rather than to take any part in the immediate control of the practical operation of the experiments. The work of each committee is largely in the hands of the director who is generally a member of the staff of the College and is thus in a good position to unite the work of the Station and the work of the Union so that each is made better by the help of the other.

Every experimenter is made responsible for his own experiment and is urged to do the very best he can for himself, for his neighbors, and for the Union. Many persons who at first took but little interest in the experiments have afterwards proven themselves to be valuable experimenters and have shown great care and accuracy in the details of their work. The names of those who conduct the experiments with the proper amount of care and accuracy are placed on the list of successful experimenters and these individuals are carefully looked after in the future. It will, therefore, be seen that the Union makes a study of the men themselves as well as the products of their labor. The education of the men in the development of accurate methods, careful observation and a deeper interest in the occupation of farming is one of the objects of the co-operative experimental work in Ontario. The speaker has no hesitation in saying that the results which have been obtained along this line are of far greater value than the entire cost of the co-operative work of the past forty years.

Nearly all co-operative experimenters have had a large amount of practical experience in farm work. Many of them have had the advantage of a good education and have also had a careful training in experimental work as they have conducted successful tests on their own farms in each of a number of years. In a good many instances the experimenters are graduates or associates of an Agricultural College. It is probably safe to say that some of the co-operative experimenters have had a better all-around training than have some of those who are doing the practical work in conducting experiments at Experiment Stations.

The Union opens up a channel through which some of the best material of the experiment station can be brought to the homes of the farmers; it makes direct application of the information gained at the station by having experiments conducted on hundreds and even thousands of farms; and it systematizes the co-operative work in such a way that the results of those experiments which have been conducted with care and accuracy can be summarized and made into valuable reports for the guidance of farmers generally. Perhaps the greatest advantage of the cooperative experimental work in Ontario is that it helps the farmers to help themselves. It combines in an admirable way the training of the hands and the training of the intellect, and is one of the greatest educational features which has been introduced throughout the rural districts of Ontario in recent years.

Great care is exercised in planning the various co-operative experiments in such a way that they can be successfully undertaken by the people who are to be benefited thereby. Some experiments are simple, and some are more complicated, but in every case the work is made as clear of comprehension, as definite of purpose, and as simple in method of operation as is consistent with the objects desired. It is the constant aim to make all experi-

ments as interesting, as valuable, and as instructive as it is possible to make them. It is probably due to the care taken in the selection and the planning of the experiments, and to the kindly interest manifested toward the experimenters themselves, that the co-operative work has becomes so extensive in its operations, so popular among the people, and so far-reaching in its results.

Printed instructions for conducting the experiments and blank forms on which to report the results are furnished to every person undertaking the work. Personal letters are also used frequently to give encouragement and friendly advice to those especially who are entering upon the work for the first time.

Reports of the co-operative tests are very carefully examined, and those which are complete and which show carefulness and reliability throughout are summarized. The average results and the special features of the various experiments are presented and discussed at the annual meeting of the Experimental Union. The results thus presented, along with the discussions thereon, are printed in the annual report of the union, of which from 30.000 to 40,000 copies are issued and distributed among the experimenters and among the farmers generally.

In the Field Husbandry Department of the Ontario Agricultural College over 2600 varieties of farm crops obtained from different parts of the world have been grown under test for five years or more and their adaptability for Ontario conditions carefully studied. From some of the varieties of greatest merit improved strains and varieties have been obtained through careful selections from large nurseries, planted by hand, with thousands of selected seeds. As a last resort, controlled cross-fertilization has been used to originate new varieties superior to those obtained through selection from the varieties of highest record. For some time past we have grown and examined annually an average of about 50,000 hybrid plants of farm crops. The plant improvement work has included grain, forage, root and tuber crops.

The co-operative experiments in Field Husbandry or Agronomy have included wheat, oats, barley, rye and buckwheat; field peas, field beans, soy beans and vetches; alfalfa, clovers, sainfoin and sweet clover; corn, sunflowers, sorghum, millet and grasses; rape, kale and cow cabbage; potatoes, mangels, sugar beets, swedes, turnips and field carrots.

There are co-operative tests with varieties of farm crops, seed selection, seed preparation and seed treatment; dates of seeding, methods of seeding and rates of seed per acre; planting and thinning at different distances, growing crops separately and in different combinations for grain and for fodder, the application of manures and fertilizers, etc.

Each experiment has contained from two to ten measured plots. These have varied in size from one one-hundred and sixtieth to one-quarter of an acre. The most common plots, however, have consisted of one-eightieth acre each and have varied in shape according to the requirements of the various experiments.

In the forty-year period there have been 107,632 distinct and separate co-operative experiments conducted in Field Husbandry alone. There were, therefore, on the average 2,691 co-operative experimenters per annum. During and immediately after the war, the number did not drop below 1,600 in any year and has been increasing again, reaching 2,831 in 1925. The number of co-operative experimenters in the present year is 637 more than in 1924 and 1,125 more than in 1923.

The cost of the co-operative experiments is paid conjointly by the Station and the Union. The Station pays for most of the labor and for some of the material and the Union for all of the stationery, printing, postage, expressage, etc., as well as for part of the material required to carry on the co-operative work. In addition to membership fees, the Union receives an annual grant from the government which has been increased from time to time and now amounts to $2700.

In order to give some idea of the financial results of the co-operative experiments the following is quoted from a report issued by the Provincial Government in 1923:—

"Crop statistics have been collected by the Ontario Department of Agriculture continuously since 1882. From this accumulated data we learn that the increases in the acre yields of barley, oats and winter wheat for the last twenty-one years, in comparison with the former years, amounted to 249,730,411 bushels which, valued at average market

prices, would reach a total of $161,049,-377.71. This amount is over thirty times as much as the net expenditure of the Ontario Agricultural College from its commencement in 1874 to the present time.

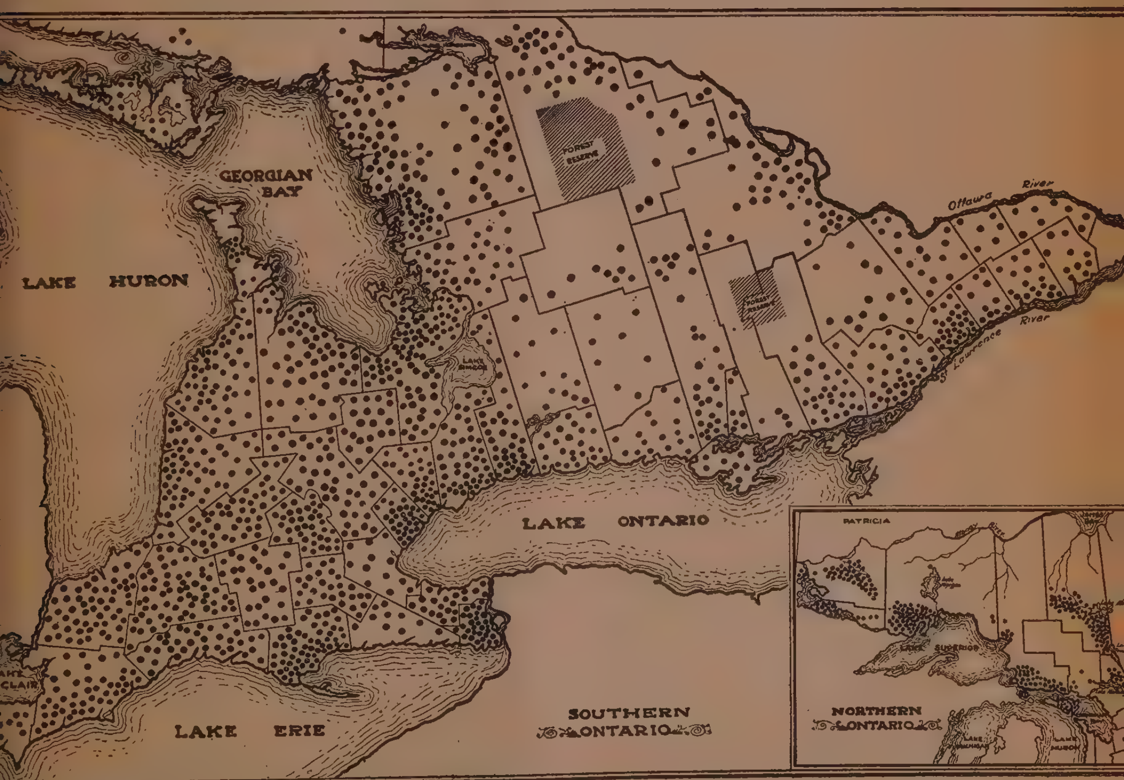
"The large increases in yields per acre of these major grain crops are even more interesting when we realize that actual decreases in acre yields, over the same period, have taken place throughout Ontario with some of the minor farm crops which have not been so influenced by new varieties originated at our College. It should be rembered that there is a natural tendency towards gradually decreasing yields of all kinds of farm crops in a comparatively new country.

"Undoubtedly, the general use of these high-yielding new varieties of good quality has been the great factor in bringing about this general increase in acre yields of the three principal grain crops on Ontario."

As a result of extensive experiments at the College and of the co-operative experiments on thousands of farms over Ontario, the highest yielding varieties of oats, barley, wheat, rye, field peas and soy beans now in use in the Province are those which we have originated at Guelph by hybridization and by selection.

Probably the most difficult and yet the most important places to unite agricultural practice and agricultural science are on the common individual farms throughout the country It seems to me that the best way to bring about this desirable condition is through the medium of a well organized system of co-operative experimental work developed through the united efforts of the farmers on their farms and the agricultural scientists who have the initiative, enthusiasm, and right ideals for this kind of work.

The Ontario Agricultural and Experimental Union after two score years of service is still increasing its work in quality and in volume, in helpfulness and in influence. It has done a great deal to foster a high type of agriculture and a wholesome, thoughtful and progressive rural life. Even a fuller development of the great work of this organization is anticipated for the future.



Location of Co-operative Field Husbandry Experiments in Ontario in 1923.
A map for 1924 would show 485 additional dots.
A map for 1925 would show 1125 additional dots.

Discussion on Educational Policies.

On page 27 of the September issue of *Scientific Agriculture,* the report of the C.S.T.A. Committee on Educational Policies was published. President L. S. Klinck, Chairman of the Committee, is anxious that there shall be full and frank discussion of that report, so that it may be put into final shape for the 1926 Convention.

The opinions of Dr. M. Cumming, Principal of the Nova Scotia Agricultural College, are published below.

Truro, Nova Scotia,
June 13, 1925.

Dear President Klinck:

Respecting the various recommendations, I cannot say that they all appeal to me. I enclose an account of the conclusions which I have temporarily, at least, arrived at, after having talked about matriculation standards with Presidents Reynolds and Harrison of the Agricultural Colleges and Presidents McLean, Murray and Tory of the Universities.

Respecting the associate course: I observe that it is recommended that when offered it should be separate and distinct from the degree course. I am not entirely satisfied with this recommendation. Many students enter Agricultural Colleges without a very clear idea as to the course which they will pursue. The more I think it over, the more I am satisfied that, while it may be at some inconvenience to the instructors, yet the students, as a rule, gain a great deal when there may be admitted to the degree course those who may ultimately proceed only as far as the second year. If this is admitted, the wisdom of providing in the first two years a course very similar to the one which has heretofore been offered in the first two years at Guelph becomes apparent.

Personally I am very much worried over what appears to be a tendency to get into the Agricultural Colleges, high school boys, often with limited farm experience, instead of real experienced farm boys, nor must it be forgotten that these farm boys are ambitious and do not like to be restricted from at least the opportunity of applying for the Bachelor's degree. I do not know whether you were ever interested in the sport of fishing, but if you were, you will remember that it was always the ambition of a good fisherman to fish in the waters where the biggest fish were to be found, even if this included the possibility of a very small fare.

I am bound to admit that although a university man myself, my past 25 years' experience has been in institutions devoted exclusively to agriculture; consequently, I may have a little different view point from men like yourself who are more closely identified with university work. I do not like the idea of the first two years of the undergraduate course being devoted to the humanities and to pure science. Even with a large measure of pure agricultural instruction in the first two years, students often obtain the idea that our agricultural courses are unpractical. This, in my judgment, will be still more the case if the first two years' instruction are restricted as suggested, and will result in keeping in our degree courses only students who are applicants for professional situations.

I am very much impressed with the recommendation referring to the providing of opportunities for post-graduate work in Canada. I think the Federal Department of Agriculture should function here. If they are short of money, I think they may well curtail some of the extensive work which is being done now and go in for more intensive work by providing greater facilities for investigation at or near the central plant and for postgraduate study at the same place.

Yours sincerely,

Signed) M. CUMMING.

QUALIFICATIONS FOR ENTRANCE TO DEGREE COURSES IN AGRICULTURE

At a conference held at the Nova Scotia Agricultural College on June 6, 1925, immediately following the Universities' Confer-

ence at Halifax, the subject of standards for entrance to the degree course in agriculture was considered. There were present, President Reynolds, Principal Harrison, Principal Cumming and several members of the staff of the Nova Scotia Agricultural College. It was proposed that it might be possible to arrive at a unanimous interim report which might be submitted to the committee appointed by the Universities' Conference to deal with this subject. A final agreement was not arrived at in this conference, but it was agreed that each of the three college heads should prepare and submit to each other a report embodying his own views of the question. In the following paragraphs the undersigned proposes to set forth his views.

Briefly, the question at issue was—should farm experience and a fair common school education, combined with the development of judgment, be accepted as equivalent to university matriculation? It was set forth that a very considerable number of students who enter Agricultural Colleges are farm boys who have attended country schools for a term of years, after which they have sought entrance to Agricultural Colleges. Until recently, many such students have been admitted to the various Colleges and have passed with high marks the actual subjects prescribed in the various branches and have been awarded the Bachelor's degree in agriculture without having passed a matriculation examination.

More recently, it has transpired that some of these agricultural graduates have sought to take post-graduate courses on a par with university graduates, to teach in collegiate institutions and to occupy positions in the Civil Service in competition with men holding university degrees. In these three instances, and possibly others, such Agricultural College graduates have been handicapped through not having passed university matriculation, certain authorities holding that their farm experience was not equivalent to university matriculation.

We still have this same class of students to deal with at Agricultural Colleges. Some of them have not regarded it as a difficult matter to study and pass university matriculation, but others, and especially those of maturer years, have found it difficult to get up the work necessary, and have considered that the time required for this purpose could be much better devoted to technical study in their own branch.

Setting aside many matters of detail, the writer, who himself holds university degrees and has for 25 years taught students in Agricultural College, is strongly of the opinion that in specific cases farm experience and evidence of judgment developed from the same, should receive recognition by academic authorities who have control of the prescribing of conditions for the Bachelor's degree in agriculture.

In further detail, it is the opinion of the undersigned in the case of those Agricultural College students seeking the Bachelor's degree in technical branches, viz., agronomy, animal husbandry, horticulture, dairying, poultry, etc., farm experience and evidence of ability should be regarded as equivalent to university matriculation and should be accepted in lieu of this qualification. On the other hand, university matriculation should be demanded of those applying for the Bachelor's degree in agriculture in the various scientific branches, viz., chemistry, botany, entomology, bacteriology, physics, etc. It is also the opinion of the undersigned that the same Bachelor's degree should be awarded to both of these groups of applicants.

Those taking the technical courses would be well qualified for the management of their own farms or for farms belonging to other parties, for County Representative positions and also for many positions in the various Civil Services. They would not, however, without further qualifications in academic subjects be admitted to post-graduate work and to such other positions in respect to which it was generally considered that university matriculation should be prescribed. Should such non-matriculants, subsequent to obtaining their Bachelor's degree, seek to pursue work in these latter lines, then the actual passing of university matriculation and possibly certain academic courses should be insisted upon.

Those taking the scientific courses for which university matriculation would be

necessary, would, under this arrangement, be on a par with those taking the various Bachelor's degree courses in universities and would be eligible, without further examination, for post-graduate courses, etc.

The undersigned realizes that the foregoing may not appeal to one who is an out and out "standardizer". None the less, the undersigned is of the belief that the Agricultural Colleges will better serve their agricultural constituencies if they evidence their appreciation of education through experience and do not rate education derived from mere academic studies as insuperably superior to the former.

(Signed) M. CUMMING.

NOTES

1. There are at least two groups of farm boys who may seek entrance to Agricultural Colleges, without having passed matriculation examination: (a) Those who, because of enforced duties or lack of access to high schools, have not had the opportunity of preparing themselves, (b) Those who have had the opportunity, but have failed to pass because of lack of ability or carelessness.

In setting forth the attached statement, the writer has had in mind only those boys of Group 1. Boys of Group 2 would be detected in their actual Agricultural College studies and would not, unless greatly reformed, be able to make the necessary standard for passing in the purely agricultural studies.

2. There may be a difference of opinion respecting the possibility of a graduate of a technical course who has obtained his degree without passing matriculation subsequently entering post-graduate schools or following unanticipated academic pursuits. The writer thinks that provision should be made under which occasionally men of this class could be admitted to such academic work. He has in mind an Agricultural College graduate who obtained his Bachelor's degree some years ago, when matriculation was not insisted upon. Several years after this man obtained his Bachelor's degree he became interested in post-graduate study and is now pursuing, with credit, his doctorate degree course at an American university. He passed his matriculation and certain other academic examinations subsequent to obtaining his Bachelor's degree. Such cases would, however, be extremely rare.

3. The question as to when this matriculation examination should be passed by those pursuing scientific courses arises. In general it will be agreed that it should be before entrance to the college. None the less, the writer is of opinion that in special circumstances, such as those due to pressure of farm work, certain students evidencing ability should be allowed to enter scientific courses without matriculation, but must pass their matriculation prior to third year entrance.

4. In preparing the foregoing, the writer has had in mind the whole Dominion of Canada. There are some thickly settled agricultural areas where a farm boy might find little difficulty in attending high schools and passing matriculation. At the same time, there are sparsely settled sections where such access to high schools is difficult and in cases of straitened financial circumstances almost impossible. Albeit, the fact remains that some of the most capable students of the writer's acquaintance have come from such localities and might have been debarred from obtaining a thorough agricultural education had strict matriculation been in force.

(Signed) M. CUMMING.

Dominion Department of Agriculture Notes.

EXPERIMENTAL FARMS BRANCH

Poultry Division

The First Registered Cockerels

With the advent of the "registered cockerels" the poultry breeder has attained a position that places him in line with breeders of other registered stock, and gives the "rooster" a place in Canada's National Live Stock Records.

The registration of this cockerel is based upon certain rules of entry which are very definite, as laid down by the Canadian National Poultry Record Association. Hens have been registered for the past three years, but the first cockerels to be admitted are now being inspected and marked. The "rules of entry" state that a male must be over six months of age and under one year, and his dam and grand dam registered, and he and his sire must have passed inspection as provided. The sire of these first registered cockerels is not a registered bird, but after December 1st, 1927, by which time there will be registered males to use as sires, it will be necessary to have three generations registered on the dam's side and a registered sire. Another important provision, and one that makes possible an adequate inspection, is that "a male is only eligible for registration providing he and his dam were bred by the same person".

The question may arise as to why all this trouble is taken and time spent in breeding and registering cockerels. The answer is—to complete the chain of policies which are even now having a marked influence on the poultry industry, and making it one of the most profitable side lines in farming.

Registration and Record of Performance for poultry are the two great links in the chain of progression. In the former, breeders enter who wish to establish registered strains of their breeds, the records upon which the registration is based being made on neutral ground, through the medium of the Laying Contest. In the case of Record of Performance, breeders enter their flocks and the records and inspections are made on their own plants. These breeders are interested in pedigree breeding, and it is from these flocks that entries are expected in the Laying Contests. It is also expected that these breeders will turn to the "registered" males as the logical means of improving their stock.

The farmer breeder has these record-of-performance flocks to draw upon for his males.

Thus the cycle is complete. The entrants in R.O.P. come from the great farm poultry flock of approximately fifty million head. The entrants in the Contest come from the R.O.P. flocks now approximating fifty thousand head. Improvement is largely carried on through the male line, and the "registered" male is the logical one for the R.O.P. breeder to secure, and the certified R.O.P. male the one for the farmer breeder to use.

"Registered" cockerels will be exhibited at the British Empire Exhibition at Wembley during the month of October. These birds will be for sale. Canada's R.O.P. and Registered stock has already received wide advertising through the World's Poultry Congress at Barcelona, Spain, last year, and also through the British Empire Exhibition. Many export sales have been made, and it is anticipated that an export demand will be created for such stock, which only Canada is in a position to fill.

Division of Chemistry

The division has recently completed the analysis and physical examination of a series of soil samples collected on the Illustration Stations of Prince Edward Island. The samples were collected by the superintendent of the branch Experimental Station at Charlottetown, and may be considered as fairly representative of the soils of that province. The data obtained will be published in the near future, but in the meantime information with respect to this investigational work may be obtained by communicating with Dr. Frank T. Shutt, Dominion Chemist, Ottawa, Ont.

Investigational work with soils and fertilizers, both in the field and laboratory, has engaged the attention of the division to a considerable extent during the present season. Practically every branch Farm and Sta-

tion of the Dominion has been visited by a representative of this division in an endeavor to correlate the field data with those obtained in the laboratories at Ottawa.

The division reports a very considerable increase in the volume of correspondence respecting the use of fertilizers, examination of soil samples, the growing of sugar beets, the analysis of farm water supplies, etc., etc., during the past year.

Division of Botany

The increasing demands made on the services of the Division of Botany for the solution of the many problems of economic botany and plant pathology have been met by the Dominion Department of Agriculture by increases of staff and the establishment of new field laboratories, so that the present organization is now as follows:

H. T. Güssow, Dominion Botanist

Economic Botany—J. Adams and H. Groh, Botanists; R. A. Inglis, Junior Botanist and Librarian.

Plant Pathology—Central Laboratory, Ottawa, Ont.: F. L. Drayton and J. B. MacCurry, Plant Pathologists; A. W. McCallum, Forest Pathologist; Irene Mounce, Assistant Plant Pathologist.

Charlottetown, P.E.I.: R. R. Hurst, Assistant Plant Pathologist, in charge.

Kentville, N.S.: J. F. Hockey, Plant Pathologist, in charge.

Fredericton, N.B.: D. J. MacLeod, Plant Pathologist, in charge; J. K. Richardson, Assistant Plant Pathologist.

Ste. Anne de la Pocatière, Que.: H. N. Racicot, Plant Pathologist, in charge.

St. Catharines, Ont.:G. H. Berkeley, Plant Pathologist in charge; A. B. Jackson, Assistant Plant Pathologist.

Winnipeg, Man.: Senior Plant Pathologist, in charge, vacant; D. L. Bailey, J. H. Craigie, J. B. Sandford, M. Newton, Plant Pathologists; F. J. Greaney and T. Johnson, Assistant Plant Pathologists.

Brandon, Man.: I. L. Conners, Plant Pathologist, in charge.

Saskatoon, Sask.: Senior Plant Pathologist, in charge, vacant by the resignation of W. P. Fraser; R. C. Russell and G. A. Scott, Assistant Plant Pathologists.

Indian Head, Sask.: P. M. Simmonds, Plant Pathologist, in charge.

Summerland, B.C.: H. R. McLarty, Plant Pathologist, in charge.

Inspection and Certification Services—A spray service in the Niagara Peninsula, and a certification of potatoes and raspberries is conducted by some of the staff, with one chief inspector, eight district inspectors, and thirty-eight temporary inspectors, in addition to the staff listed above.

Tobacco Division

Mr. H. A. Freeman, of the Tobacco Division, has returned from a successful season at Wembley. Our tobaccos stimulated much interest among the British brokers, and it is hoped that a substantial increase in our tobacco exports will result.

Mr. Robert J. Haslam, B.S.A., McGill 1925, has been recently appointed Tobacco Inspector for Ontario with temporary headquarters at the Harrow Experimenatl Station. Mr. Haslam is at present engaged in field survey work in southwestern Ontario, and in assisting with the tobacco experiments at the Harrow Station.

ENTOMOLOGICAL BRANCH

Mr. Arthur Gibson, Dominion Entomologist, visited the entomological laboratories in the Maritime Provinces in August. Special visits were paid to the fruit section of the Annapolis Valley, the potato section in Carleton county, N.B., and districts in Prince Edward Island. While in the latter province, meetings at West Devon and Richmond were held, at which the work of the Branrh was discussed with the farmers present.

An important meeting of entomologists and corn growers interested in the control of the European corn borer, was held at Chatham on September 17 and 18. The Branch was represented by Messrs. Gibson, Crawford, Keenan and Baird. At the meeting, Dr. Grisdale the Deputy Minister, and the Hon. Mr. Martin, Minister for the province of Ontario, were present.

Two excellent exhibitions of insects and their work were attractively displayed at the Ottawa and Toronto Exhibitions, and received many favourable commendations. These were prepared under the direction of Mr. C. B. Hutchings of the Division of Forest Insects.

The Entomological Branch has recently published Bulletin No. 52 N.S. entitled "The Colorado Potato Beetle in Canada." This is a biological study of this important pest and contains much original information.

Division of Forest Insects

Dr. Swaine returned to Ottawa early in September from Newfoundland where he had been investigating certain forest insect problems, notably the Eastern Spruce Bark-beetle of which there has been a severe outbreak in the Colony.

On returning, Dr. Swaine spent a short time in Nova Scotia and New Brunswick in going over with resident officers certain phases of the work, particularly that relating to forest insects.

In the early part of August, Mr. R. Hopping, in charge of forest insect work in British Columbia, visited the Bakerville section of the Fraser valley, in company with Mr. E. C. Manning of the British Columbia Forest Branch, on an inspection of the spruce budworm outbreaks in that region.

Division of Foreign Pests Suppression

Plans are now being drawn for the erection of a modern inspection and fumigation station in Montreal. The building is to be erected near the docks and when completed will be available for fumigating grain, nursery stock, etc.

During the past season control operations were carried out in connection with the gipsy moth outbreak at Henrysburg, Que. These include the creosoting of all egg clusters found and the spraying of all foliage twice with arsenate of lead, in the vicinity of the infestations. Scouting operations for this insect have been carried out in southern Quebec in cooperation with the Quebec Department of Lands and Forests. No additional infestations have been found. Scouting for the European Corn Borer has been carried out in southern Ontario during the latter part of July, August and September.

Division of Field Crop and Garden Insects

Mr. H. G. Crawford, Chief of the Division of Field Crop and Garden Insects, recently returned to Ottawa from western Canada, where he visited the different laboratories connected with the Division.

Mr. A. G. Dustan has been transferred to Ottawa to take charge of Truck Crop Insect Investigations.

Messrs. Crawford, Criddle, Seamans and King were in attendance at the meeting of the International Committee on Farm Pests, held at St. Paul, Minnesota, on September 3 and 4.

Mr. N. J. Atkinson of the Saskatoon laboratory has been awarded a Bursary by the Canadian Research Council to study various phases of the Red-backed Cutworm problem at the University of Saskatchewan.

Division of Systematic Entomology

Three steel cabinets with 150 insect drawers have recently been acquired for this Division and will be used in expanding the Canadian National Collection of Insects. Five years ago this collection was contained in 12 cabinets and 600 drawers. Today it occupies 30 cabinets and 1,550 drawers and has largely been thoroughly classified according to the latest authorities. In this connection more than 500 new Canadian species have been described. The collection now ranks among the leading ones of the continent and is constantly being consulted by workers of the United States and Europe; colleges, schools and other institutions in Canada also avail themselves freely of the opportunity now offered, of having their insect collections correctly named.

Among the more recent taxonomic papers by officers of the Division may be mentioned the following:

New Canadian Ephemeridae with Notes, III, by J. McDunnough, Chief of the Division.

Nearctic Species of Genus Rhaphium, by C. H. Curran, Entomologist in charge of Diptera.

Preliminary Revision of the Campopleginae in the Canadian National Collection, by H. L. Viereck, Assistant Entomologist in charge of Hymenoptera.

La Revue Agronomique Canadienne

RÉDACTEUR—H. M. NAGANT

La Bouillie Bordelaise et sa Composition Chimique.

A. LEDUC

Professeur à l'Institut Agricole d'Oka

Une revue de l'abondante littérature traitant des phénomènes physico-chimiques compliqués qui se présentent dans l'étude de la bouillie bordelaise ou des effets physiologiques et fongicides, etc., de ce mélange dépasserait les limites du petit article que je désire écrire sur cette matière.

Aussi, intéressé surtout dans l'étude chimique de la bouillie bordelaise, je me contenterai, pour cettefois, d'une courte investigation sur sa composition chimique, l'un de ses aspects un peu obscur, moins étudié, moins bien connu.

Une classification des bouillies bordelaises, le groupement des investigateurs sur ce fongicide, son étude chimique proprement dite et le résumé d'un travail de Pickering feront l'objet de ce travail.

Types de bouillies bordelaises actuellement en usage.

Bouillie bordelaise! Ce mot, il y a une dizaine d'années, s'employait sans qualificatif, car il n'y avait à cette époque, qu'une sorte de bouillie bordelaise, c'était la bouillie liquide. Aujourd'hui, la bouillie liquide a deux rejetons assez importants pour nous obliger à en tenir compte et à faire une distinction, c'est la bouillie en pâte et la bouillie en poudre. Mais ces deux dernières formes de bouillie ne diffèrent pas beaucoup de la première, elles ont la même composition, elles se composent des mêmes substances, la bouillie liquide contient plus d'eau que les deux autres, voilà tout.

La bouillie liquide fera seule l'objet de notre étude.

La bouillie bordelaise peut se diviser en trois classes suivant sa réaction:

(a) La bouillie bordelaise acide.

(b) La bouillie bordelaise légèrement alcaline.

(c) La bouillie bordelaise fortement alcaline ou basique.

La bouillie bordelaise acide est celle qui contient une petite quantité de cuivre soluble (sulfate de cuivre en excès) qui donne une réaction faiblement acide, (cette réaction acide est due au fait que le sulfate de cuivre est un sel acide, un sel résultant de l'union d'un acide fort avec une base faible).

En pratique, on fait, d'ordinaire, ce mélange en ajoutant un lait de chaux, $Ca(OH)_2 + H_2O$, à une solution de sulfate de cuivre, $CuSO_4$, jusqu'à ce qu'on obtienne une réaction alcaline, puis l'on ajoute une petite quantité de sulfate de cuivre, 0.1% dans le cas d'une bouillie à 1 pour cent (1 pour cent de sulfate de cuivre) comme dans la formule 4-4-40, et O, 2% dans le cas d'une bouillie à deux pour cent. Il est évident que la bouillie bordelaise ordinaire ne donne pas une réaction acide, à cause de l'excès de chaux employée dans sa fabrication. Le rapport sulfate de cuivre à la chaux dans une bouillie neutre étant come 1 est à 0.224 (suivant l'équation de Millardet donnée plus loin) doit être un peu plus étroit dans le cas d'une bouillie acide, v.g. 1 est à 0.2, 1 est à 0.195.

La bouillie bordelaise légèrement alcaline s'obtient par l'addition de lait de chaux à une solution de sulfate de cuivre jusqu'à ce qu'on ne puisse plus découvrir de cuivre soluble au moyen du ferrocyanure de potas-

sium — $2CuSO_4+K_4Fe(CN)_6=Cu_2Fe(CN)_6$, précipité brun, indicateur de cuivre soluble, $+2K_2SO_4$—ou, plus souvent, par l'addition de lait de chaux jusqu'à l'obtention d'une réaction alcaline. Un mélange dont le rapport sulfate de cuivre à l'oxyde de calcium est comme 1 est à 0.3 tombe dans ce groupe.

La bouillie bordelaise fortement alcaline ou basique est une bouillie contenant du sulfate de cuivre et de la chaux vive dans le rapport de 1:0.5, pas moins. Des mélanges ayant les rapports 1:3 et 1:5 ont même été et sont actuellement employés avec succès—introduits par Sanders et Brittain, Nouvelle-Ecosse—formules 2-10-40, 3-10-40.

Faisons remarquer que ce rapport du sulfate de cuivre à la chaux a une grande influence sur la composition chimique de la bouillie, son état physique et ses effets biologiques.

Ce sont les mélanges légèrement alcalins et basiques que l'on emploie surtout, aujourd'hui. Ils contiennent de 0.5 à 1.6% de sulfate de cuivre; la quantité de chaux vive employée étant rarement moindre que celle de sulfate de cuivre, plus souvent égale à la quantité de celui-ci, v.g. 4-4-40, assez souvent plus grande, spécialement dans ces mélanges qui contiennent moins de 1% de sulfate de cuivre, v.g. 2-10-40.

Aux Etats-Unis et au Canada, on se sert, pour les cultures potagères, de la bouillie classique et pratique 4-4-40, bouillie qui contient une quantité égale de sulfate de cuivre et d'oxyde de calcium et qui est basique et, pour les vergers, de la bouillie 4-4-40, 2-10-40 ou 3-10-40, ces deux dernières dans les régions pluvieuses.

Pour se rendre compte des changements opérés dans la composition de la bouillie bordelaise, depuis 1885, c'est-à-dire depuis le mélange de Millardet, l'un des premiers mélanges scientifiquement préparés, sinon le premier, considérons la composition de ce mélange:

Sulfate de cuivre	5.71	parties
Chaux vive	10.71	"
Eau pour faire	100.	"

Le rapport sulfate de cuivre à la chaux était comme 1 est à 2 le pourcentage de sulfate de cuivre 5, très élevé, ce qui signifiait bouillie coûteuse.

Groupement des investigateurs suivant leur opinion sur la composition chimique de la bouillie bordelaise.

Il y a une divergence d'opinion très marquée quant à la composition de la bouillie bordelaise; la littérature sur le sujet nous fait vite voir combien les auteurs ne s'accordent pas sur les propriétés physiques et chimiques de ce mélange.

Aussi, il me semble que nous pouvons diviser les chercheurs sur la composition de la bouillie bordelaise en trois écoles, dont l'une semble prédominer sur les autres, si elle n'est pas la seule suivie, aujourd'hui. Cette division est basée, comme nous le verrons dans le paragraphe suivant, sur l'opinion des investigateurs quant à la composition chimique de la bouillie bordelaise, quant à l'équation chimique représentant la réaction qui a lieu lorsque du lait de chaux est ajouté à une solution de sulfate de cuivre.

Je nommerai, la première de ces écoles, celle de Millardet; cette école semble perdre du terrain et même presque abandonnée. J'appellerai la seconde, école intermédiaire: elle est de peu d'importance. La troisième école, celle de Pickering, date de 1907; c'est l'école à laquelle semblent adhérer presque tous les investigateurs dont j'ai lu les travaux, Sicard, 1914, Butler 1923, Sanders et Brittain, et presque tous ceux qui s'occupent de cette question depuis 1907.

Cette division. n'aurait-elle comme avantage que de faciliter la compréhension de l'abondante littérature sur la question, aurait déjà assez de valeur, il me semble.

Composition chimique de la bouillie bordelaise

Les bouillies bordelaises, soit acides, soit légèrement ou fortement alcalines, dont j'ai parlé au début, sont préparées par l'addition d'un lait de chaux froid à une solution froide de sulfate de cuivre.

Les réactions qui ont lieu quand de l'eau de chaux ou un lait de chaux est ajouté à une solution de sulfate de cuivre sont assez complexes, et, par conséquent, il y a manque d'accord à leur sujet, comme je l'ai déjà dit, entre les différents chercheurs qui ont étudié la chimie de la bouillie bordelaise, d'où la division en trois écoles, faite plus haut.

Qu'est-ce que la bouillie bordelaise, suivant ces écoles?

Suivant l'école de Millardet, ce qui, pour moi, veut dire suivant Millardet, Gayon, Chester et la majorité des écrivains sur le sujet avant 1907, la réaction qui a lieu quand on mélange un lait de chaux à une solution de sulfate de cuivre donne, comme résultat de l'hydroxyde de cuivre et du sulfate de calcium, avec de l'hydroxyde de calcium dans le cas de l'emploi d'un excès de chaux dans la préparation du mélange, ce qui est presque toujours le cas. L'équation suivante représente la réaction qui a lieu quand la quantité de chaux employée est juste suffisante pour rendre la réaction complète:

$$CuSO_4+Ca(OH)_2+H_2O=Cu(OH)_2+CaSO_4+H_2O.$$

Le rapport sulfate de cuivre à l'oxyde de calcium répondant à cette équation est

$$\frac{CuSO_4.5H_2O=249}{CaO = 56} = \frac{4.44}{1}$$

ou 1: 0.224—réaction de l'école de Millardet —comparé au rapport 1: 0.166,—réaction de l'école de Pickering.

La nouvelle école, c'est-à-dire celle de Pickering, est basée sur une étude des plus complètes faite sur la composition chimique de la bouillie bordelaise par Pickering, en 1907. La majorité de ceux qui s'intéressent à l'étude de la bouillie bordelaise depuis ce temps, et parmi lesquels j'ai déjà mentionné Sicard, Butler et, je crois, Sanders et Brittain, semblent adhérer à cette école.

Suivant ces investigateurs, le cuivre est précipité sous forme de différents sulfates basiques de cuivre au lieu d'hydroxyde de cuivre. Les sels basiques suivants seraient formés quand le cuivre du sulfate est précipité par l'hydroxyde de calcium: $4CuO.SO_3$, $5CuO.SO_3$, $10CuO.SO_3$, $10CuO.SO_3.3CaO$, $CuO.3CaO$.

Les équations représentant la formation des sels mentionnés plus haut, à l'exclusion de CuO.3CaO qui ne serait pas très important, sont les suivantes:

Les quantités de sulfate de cuivre et d'hydroxyde de calcium requises pour la formation des sulfates basiques indiqués plus haut sont:

Pour $4CuO.SO_3$, 6 parties de sulfate de cuivre contre 1.32 parties d'hydroxyde de calcium (1 partie d'oxyde de calcium, CaO). Le rapport du sulfate de cuivre à la chaux est 1: 0.166. Millardet et Gayon avaient eux aussi observé un rapport 1: 0.179 sans cependant changer leur équation.

Pour 5CuO.SO3, 5.5 parties de sulfate de cuivre contre 1.32 parties d'hydroxyde de calcium (1 partie de CaO); rapport, 1: 0.181.

Pour 10 $CuO.SO_3$, 5 parties de sulfate de cuivre contre 1.32 d'hydroxyde de calcium (1 partie de CaO): rapport, 1: 0.2.

Pour 10 $CuO.So_3.3CaO$, 3.71 parties de sulfate de cuivre contre 1.32 parties d'hydroxyde de calcium (1 partie de CaO); rapport, 1: 0.269.

Comparons, maintenant, les rapports du sulfate de cuivre à l'oxyde de calcium qu'indique l'équation de Millardet avec le rapport suivant l'équation de Pickering.

Dans le cas de l'équation de Millardet 4.44 parties de sulfate de cuivre contre une partie d'oxyde de calcium donneraient un composé neutre, tandis que dans le cas de l'équation de Pickering 6 parties de sulfate de cuivre contre une partie d'oxyde de calcium donneraient un composé basique au lieu d'un composé acide comme ce serait le cas suivant l'équation de Millardet. Nous devons nous rappeler que Millardet à trouvé qu'un composé non acide pouvait être obtenu avec un rapport de 1: 0.179 et il semble qu'il doit avoir pensé que d'autres réactions que celle qu'il a donnée devaient avoir lieu entre le sulfate de cuivre et l'hydroxyde de calcium. Ceci confirme, semble-t-il, l'exactitude de l'équation de Pickering.

Maintenant, suivant l'équation de Pickering, 10 $CuO.SO_3.3$ CaO s'obtient avec un rapport de 1: 0.269 ou 3.71 parties de sulfate de cuivre contre une partie d'oxyde de calcium et est le composé le plus basique formé. Qu'arrive-t-il donc danc le cas de la formule

4 $CuSO_4$	+ 3 $Ca(OH)_2$	=	$4CuO.SO_3$	+3 $CaSO_4$	+$3H_2O$
5 "	+ 4 "	=	5 "	+4 "	+4 "
10 "	+ 9 "	=	10 "	+9 "	+9 "
10 "	+12 "	=	$10CuO.SO_3.3CaO$	+$9CaSO_4$	+$12H_2O$.

écente 2-10-40 dans laquelle nous avons une artie de sulfate de cuivre contre 5 parties 'oxyde de calcium, ou un rapport de 1: 5. st-ce que le $CuO.3CaO$ classé plus haut omme peu important absorbe ce très large urplus de chaux?

Il y a, évidemment, un plus grand excès de haux dans nos bouillies basiques si c'est 'équation de Pickering qui est la bonne que i c'est celle de Millardet.

Comme le cuivre n'agit qu'à la condition 'être dissout, il pourrait être bon d'ajouter ue les sulfates basiques de cuivre, tétra et entasulfate, sont quelque peu solubles dans a liqueur-mère, le tétrasulfate suivant la roportion de 1 partie dans 40,000, le pentaulfate, de 1 à 2 parties par million. Cependnt, les autres sels basiques sont complètement insolubles dans la liqueur-mère, quoique, si nous commençons par le 10 $CuO.SO_3$ ls se dissolvent avec une rapidité croissante n présence du dextrose, du saccharose et 'autres substances organiques qui donnent a réaction du biuret.

Notons aussi qu'un sulfate peut être transormé en un autre par l'addition requise de ulfate de cuivre ou de lait de chaux, suivant e cas. Si nous prenons, par exemple, le sulate basique 4 $CuO.SO_3$, nous pouvons par 'addition de plus de lait de chaux obtenir 'importe lequel des sulfates basiques suiants, ou des mélanges de sulfates basiques. ar l'addition de lait de chaux en quantités uccessives suffisantes, nous pouvons passer u $4CuO.SO_3$, dense et vite déposé, à une série e sels gélatineux et susceptibles de rester onguement en suspension.

De l'école intermédiaire, dont nous ne irons qu'un mot, mentionnons Sostegni 1890). Sostegni conclut de ses recherches ue le précipité de la bouillie est composé 'hydroxyde decuivre, de sulfate basique de uivre et d'un sel double de cuivre et de haux, $CuCa(SO_4)_2$.

Mentionnons encore Vermorel et Dantoni 1914) qui croient que le cuivre est précipité ous forme de sulfates basiques dans le cas es bouillies acides, mais que dans les soluons alcalines de l'hydroxyde de cuivre est resque exclusivement formé quand le lait ersé vivement dans une solution de sulfate de cuivre, et des sulfates basiques quand il est ajouté très lentement.

A la vérité, la nature des constituants de la bouillie bordelaise n'est pas définitivement connue.

Mais il semble que l'on ne peut sérieusement croire à la présence d'hydroxyde de cuivre comme produit de la réaction, car cet hydroxyde, comme on le sait bien, perd son eau et sa couleur bleue très rapidement, devenant noir, $Cu(OH)_2 = H_2O + CuO$, noir, tandis que la bouillie bordelaise reste bien bleue pour un temps illimité et les rapports du sulfate de cuivre à l'oxyde de calcium trouvés par Pickering et soupçonnés par Millardet luimême conduisent à la même conclusion.

Nous savons, cependant, que la potasse caustique, en quantité excédant celle qui est requise pour former du sulfate basique de cuivre, donne lieu à la formation d'hydroxyde de cuivre et que dans nos bouillies bordelaises l'alcali est en excès considérable.

Mais Pickering a trouvé, comme j'ai l'intention de l'indiquer ci-après, que l'excès d'hydroxyde de calcium ne se comporte pas de la même manière que l'excès de potasse.

Méthode suivie par Pickering dans son étude de la bouillie bordelaise.

Comme l'étude de Pickering sur le précipité du cuivre dans la bouillie bordelaise est très importante et qu'elle peut être considérée comme complémentaire de ce travail, je crois qu'il est bon de résumer ici sa méthode d'investigation.

Pickering étudiait le précipité de la bouillie bordelaise en cherchant quelle quantité d'alcali, généralement soit de l'hydroxyde de sodium, soit celui de calcium, était requise pour précipiter complètement le cuivre ainsi que la quantité nécessaire pour produire une réaction alcaline, utilisant quelques gouttes de phénolphtaléine comme indicateur.

Il faut dire que les précipités dans ces réactions sont toujours très abondants et floculeux et que la fin de la précipitation ne peut se constater par leur déposition et l'addition de plus d'alcali; la filtration est nécessaire; et la méthode suivie consistait dans l'addition de quantités variables de l'alcali à des quantités égales du sulfate et à vérifier par des approximations successives la quan-

tité d'alcali nécessaire pour assurer une précipitation complète (sans doute cela peut se vérifier, dans certains cas, par un essai plus sensible que l'addition d'alcali).

Des poids connus de sulfate de cuivre et de chaux en solution étaient mélangés et alors il ne restait qu'à déduire la composition du précipité formé par la détermination de ce qui restait dissous dans le liquide, c'est-à-dire, ou bien du sulfate de calcium seulement, ou bien du sulfate et de l'hydroxyde de calcium quand un excès de chaux avait été employé: l'hydroxyde de calcium était déterminé par titration et le sulfate, ou bien par le sulfate de baryum, ou bien par évaporation à sec et ignition.

Pour prouver la valeur de ses équations au sujet de la bouillie bordelaise, c'est-à-dire de la formation de sulfates basiques au lieu l'hydroxyde de cuivre, Pickering fit des essais spéciaux qu'il décrivit sous le titre "Réactions des sulfates métalliques avec les alcalis caustiques".

Pickering découvrit que l'addition d'alcali à des solutions de sulfates métalliques précipitait un sulfate basique bien défini, sauf dans le cas du maganèse et du magnésium où les hydroxydes sont précipités après complète précipitation, un apport plus grand d'alcali changerait le sulfate basique, ou bien en un autre, quelquefois consécutivement en deux autres produits plus basiques (par exemple le cuivre et le nickel), ou bien en hydroxide (aluminium). Quand c'est l'un des alcalis les plus actifs (potasse, soude) et qu'il est ajouté en excès, le produit est probablement toujours l'hydroxyde, mais, avec la chau tel n'est pas le cas, même avec les sulfates c cuivre et de nickel.

Il serait peut-être intéressant d'ajouter qu dans les essais faits, différents alcalis doi nèrent les mêmes résultats quant à la basicit des sulfates précipités par eux dans chaqu cas particulier. L'existance des Il sulfate basiques suivants fut constatée de cette ma ière: la présence de 5 comme cöefficient de équivalents d'oxyde métallique présent e remarquable. Ceux précédés d'une astérisqu sont ceux obtenus quand tout le métal a ét précipité de la solution, les autres sont de produits de l'action de quantités plus grande d'alcali: *$5NiO.3SO_3$, $5NiO.2SO_3$, *$5Al_2O$ *$4CuO.SO_3$, *$4CaO.SO_3$, *$CdO.SO_3$, $5CuO$ SO_3, $5NiO.SO_3$ *$5ZnO.SO_3$, $10CuO.SO$ *$10FeO.SO_3$.

CONCLUSION

Qu'est-ce que la bouillie bordelaise au poi de vue chimique? Aucune réponse certai n'est encore possible. L'opinion qui sembl la mieux fondée et la plus en honneur actue lement est, d'après la littérature que j'ai p me procurer sur le sujet, que la bouillie bo delaise se compose de sulfates basiques d cuivre et de sulfate de calcium.

Le fait que la bouillie reste bleue, appuy par l'important travail de Pickering, prouv fortement contre la présence d'hydroxyde d cuivre.

Une répétion des recherches de Pickerin par d'autres investigateurs pourrait aider solutionner ce problème d'intérêt non seul ment scientifique mais aussi pratique.

Necrologie

La mort du Révérend Frère Liguori.

La plupart des journaux ont consacré des articles élogieux et émus à la mémoire du Révérend Frère Liguori, ancien Chef du Service Avicole de la province de Québec, rédacteur du "Bulletin de la Ferme", et membre fidèle de la C.S.T.A. depuis l'année 1921.

Aussi, tous les lecteurs auront déjà eu connaissance du décès inopiné de notre confrère, survenu le 31 août dernier à Sherbrooke où il représentait officiellement le Département de l'Agriculture à l'exposition qui avait lieu en cette ville. Ils sauront également que le défunt, qui portait, dans le monde, le nom de Patrice Blais, était natif de Ham Nord, dans les Cantons de l'Est, et qu'il n'était âgé que de 55 ans.

Avec le Révérend Frère Liguori disparait une des figures les plus typiques et les mieux connues des milieux agronomiques de la Province de Québec, depuis une vingtaine d'années.

Doué d'un talent d'observation absolument remarquable auquel il joignait un style alerte et une tournure d'esprit naturellement humoristique, il possédait tout le tempérament du propagandiste et du journaliste par vocation, qui sait piquer au vif l'attention et amuser le lecteur. Son fameux opuscule intitulé: "Le Diable est aux vaches" tiré à plusieurs éditions, restera d'ailleurs un petit monument de ce genre qui consiste à faire rire de bon coeur de certains travers tout en donnant une salutaire leçon.

Mêlé intimement aux débuts de l'enseignement agricole organisé à La Trappe d'Oka, fondateur de l'Union Expérimentale des Agriculteurs de la province de Québec, le Frère Liguori dépensa, sans compter, ses talents au service de l'agriculture, en général, et de l'expansion des méthodes avicoles perfectionnées, en particulier. Il fut pendant nombre d'années collaborateur attitré du Journal d'Agriculture officiel, où ses chroniques sur l'exploitation des volailles apportaient toujours un élément de saveur originale. Appelé par le Départment de l'Agriculture à organiser, dans la Province, le Service Avicole dont il devint le chef, il continua à pousser activement au développement de cette branche de l'agriculture, par ses conférences, ses écrits et ses expériences.

Déjà atteint du mal qui devait l'emporter prématurément, le Révérend Frère Liguori avait démissionné comme chef du Service Avicole, depuis une couple d'années, pour se consacrer plus exclusivement à la rédaction du "Bulletin de la Ferme" dont il était l'esprit animateur par la verve toujours abondante et aiseé qu'il y déversait, chaque semaine, sous plusieurs pseudonymes.

Pour la nombreuse génération des jeunes agronomes, ce pionnier de la cause agricole représentait déjà, suivant l'expression de l'un d'eux, le bon vieux meuble, de forme peu ordinaire, au style original, qu'on estime et qu'on respecte parce qu'il en a vu beaucoup dans la maison où il semble indispensable. C'est pourquoi nous conserverons tous un souvenir ému du Révérend Frère Liguori dont la carrière bien remplie et féconde occupera tout un chapitre au Grand Livre de l'agriculture du Québec.

H.M.N.

ACTIVITES DES SECTIONS

Section de Québec

Les membres de la section de Québec ont tenu une assemblée régionale le 10 septembre dernier, à Québec. L'hôte d'honneur fut le Dr. H. Barton, doyen de la faculté d'agriculture du Collège Macdonald et ancien président général de la Société. Ce dernier fit une intéressante causerie sur l'oeuvre de la Société depuis qu'elle existe.

Addressèrent aussi la parole à cette assemblée, MM. H. M. Nagant, Alphonse Désilets, L. de G. Fortin et plusieurs autres. Il fut question de l'érection du monument Marsan et Mr. Geo. Duquet, artiste de Québec s'était rendu à l'assemblée pour soumettre un projet de plan qu'il avait préparé à la demande du comité d'organisation. Il fut aussi question de la formation d'une nouvelle section dont le siège serait à Ste-Anne de la Pocatière, portant ainsi à trois les sections françaises de la Société. Les membres de Québec, tout en regrettant la perte de plusieurs confrères qui feront ainsi partie de la nouvelle section, en feront cependant le sacrifice pour la commodité de ces derniers et pour le bien général de la Société.

O.C.

NOUVELLES DE NOS ECOLES D'AGRICULTURE

Dès la rentrée de Septembre, le nombre des élèves de l'Institut Agricole d'Oka a dépassé le chiffre de cent. Sur ce total, plus de 40 sont inscrits dans la première année du Cours Moyen, ce qui démontre bien que le nombre de jeunes gens désirant faire un cours d'agriculture avec l'idée arrêtée de retourner travailler sur la terre, va en augmentant.

Les 19 et 20 Septembre a eu lieu la première réunion du Conventum des finissants de l'année 1920, sous la présidence de monsieur Arthur Lamarre, agronome officiel du comté de Laprairie. Etaient en outre présents les camarades: Rosario Cartier, Anthime Charbonneau, Albert Gosselin, Alfred Leclerc, Paul Méthot, Jos. Parenteau, Elphège Marseille, Gérard Tremblay et Paul-Henri Vézina. Plusieurs autres, empêchés par des circonstances indépendantes de leur volonté s'étaient fait excuser.

Notons que la plus joyeuse animation n'a cessé de régner au cours de cette réunion où le principe de la création d'une Amicale englobant tous les anciens élèves de l'Institut Agricole d'Oka a été posé.

Nos dirigeants de l'Agriculture à l'honneur.

C'est certainement avec satisfaction que les lecteurs de la Revue Agronomique auront appris l'octroi de hautes distinctions à plusieurs des têtes dirigeantes de l'Agriculture, pour mérites acquis dans la sphère de leurs activités.

C'est pourquoi nous adressons l'hommage de nos sincères félicitations à: L'Honorable J.-Ed. Caron, ministre de l'Agriculture de la province de Québec, qui vient d'être créé Commandeur du Mérite Agricole de France, ainsi qu'à l'Honorable J. E. Perreault, ministre de la Colonisation de la même province, et à messieurs J. H. Grisdale et J.-Antonio Grenier, sous-ministres de l'agriculture, respectivement au Fédéral et au Provincial, qui ont reçu le titre de Commandeur de l'Ordre du Mérite Agricole.

Le Recrutement des Membres.

Nous sommes heureux de pouvoir annoncer un résultat des plus encourageants dans l'effort de recrutement tenté ces derniers temps.

Depuis le mois d'avril, 27 membres nouveaux ont été admis dans les deux sections françaises de la C.S.T.A. Parmi les derniers inscrits figure monsieur Henry E. Lefèvre ingénieur agronome de l'Institut Agronomique de Paris, délégué, pour l'Amérique du Nord, de l'Association Amicale des anciens élèves de l'Institut National Agronomique et représentant de la Société Commerciale des potasses d'Alsace à New York. Nous souhaitons une cordiale bienvenue à monsieur Henry E. Lefèvre dont l'entrée dans notre Association représente un heureux trait d'union entre le corps des techniciens agricoles du Canada et l'une des sociétés d'agronomes les plus considérés de France.

H.M.N.

Concerning the C.S.T.A.

APPLICATIONS FOR MEMBERSHIP

The following applications for member-hip have been received during the month f September:—

habot, H. (Laval, 1923, B.S.A.) Cap Rouge, P.Q.

lliott, G. A. (Toronto, 1921, B.S.A.) Ottawa, Ont.

alliday, G. C. (McGill, 1913, B.S.A.) Saw-yerville, P.Q.

efèvre, H. E. (Paris, 1920, I.A.) New York, N.Y.

albot, J. M. (Laval, 1915, B.S.A.) Quebec, P.Q.

rueman, H. L., (Toronto, 1921, B.S.A.) Kemptville, Ont.

Valker, J. (Alberta, 1924, B.S.A.) Indian Head, Sask.

Two senior students have also been admit-ed under the new classification of "Student Members":—

Perrault, C., Macdonald College, P.Q.

Reynolds, W. B., O.A.C., Guelph, Ont.

MEMBERSHIP CAMPAIGN

A Dominion-wide membership campaign vas launched about the middle of September, nd a booklet was sent to all eligible mem-ers in Canada. The same booklet was also ent to all members in an effort to hasten the ayment of renewal fees and to stimulate in-erest in the Society's work.

It is too early to known what the result of he campaign will be, but it is expected that here will be a steady increase in membership ntil the end of the calendar year. At that ime the privilege of joining the Society for 6.00 will expire and an additional initiation ee of $5.00 will become effective.

Members can do much to assist in this cam-aign by urging non-members with whom hey come in contact to join the Society.

DATES FOR 1926 CONVENTION

While definite dates have not yet been decided upon, it is probable that the sixth annual convention of the C.S.T.A. will be held on June 23rd to 26th, 1925. The meetings will be held at Ottawa.

Dates for the annual meeting of the Canadian Seed Growers' Association, to be held at the Oka Agricultural Institute, will be June 21 and 22, with the committees of Plant Breeders meeting at Macdonald College on June 18 and 19.

The Macdonald College Alumni Association, in view of the above two Conventions, is planning to hold a re-union of graduates, at the College, either before the C.S.G.A. meetings or at the close of the C.S.T.A. Convention.

EASTERN ONTARIO LOCAL

The eastern Ontario local is opening its winter programme with a dance at the Chateau Laurier on October 23rd. A series of luncheons will be held on the first Friday of each month during the winter, starting on November 7th. The present membership is 101.

MONTREAL LOCAL

The opening meeting of this local is being held at the Laval University Club on Saturday, October 10th, and will be followed by regular monthly luncheons thereafter.

A joint meeting of all Quebec members is likely to be held at the Windsor Hotel, Montreal, at the time of the Quebec Apple Show during the first week of November.

FIFTY NUMBERS

The present issue is the fiftieth number of *Scientific Agriculture* to be published under Society ownership. The magazine has been distributed monthly since the September issue, 1921. Six numbers were published early in 1921 by the Industrial & Educational Publishing Company, and comprised Volume 1, but the Society did not assume ownership of the magazine until July of that year.

NOTES

William Lochhead (McGill, 1885) who was Professor of Biology at the Ontario Agricultural College from 1898 until 1906, and has been Professor of Biology, as well as of Entomology and Zoology at Macdonald College since its opening in 1907, has been obliged to retire on account of ill health. He and Mrs. Lochhead will continue to reside at Ste. Anne de Bellevue, P.Q.

P. H. Ferguson (O.A.C. '20) has been temporarily appointed in charge of the Department of Economics at the Manitoba Agricultural College. He completed a year of graduate work at the University of Wisconsin last June, and was formerly a District Representative in Saskatchewan.

Robert Innes (Macdonald '11) has been appointed Deputy Minister of Agriculture for Nova Scotia, according to various reports. Bob hasn't confirmed any of them, but if they are true, he probably is too busy.

N. F. Wilson (O.A.C. '96) will be one of the two Ottawa Liberal candidates in the forthcoming Dominion elections.

P. E. Light (O.A.C. '11) of the Dominion Live Stock Branch, who has been at the Wembley Exhibition during the past summer is expected to return to Ottawa in November.

L. C. McOuat (Macdonald '15) was one of the two Canadian representatives at the meetings of the Imperial Economic Committee in London, England, this summer. The other representative was J. Forsyth Smith, Canadian Trade Commissioner at Liverpool.

T. C. Vanterpool (Macdonald '23) has been awarded the Hudson Bay Scholarship and is taking graduate work at the University of Manitoba under Dr. Buller.

C. J. Watson (Macdonald '21) of the Chemistry Division at the Central Experimental Farm, is completing his graduate studies at Cornell University this winter.

W. G. MacDougall (Macdonald '15) has been appointed Assistant Superintendent of the Dominion Experimental Station at Lennoxville, P.Q. He has been District Representative (Agronome) at that point since 1916.

B. Leslie Emslie, Director for Canada of the Chilean Nitrate Educational Bureau, has just returned to Toronto after spending two months in England and Scotland, and on the Continent. He is President of the Western Ontario Branch of the C.S.T.A.

The following attended a Directors' meeting of the Canadian Seed Growers' Association at Ottawa on September 5th: Dr. C. A Zavitz (O.A.C. '88), G. H. Clark (O.A.C. '98), R. Summerby (Macdonald '11), T. J Harrison (Manitoba '11), and P. Stewar (O.A.C. '14).

J. G. Davidson (O.A.C. '22) has been appointed to the staff of the Maple Leaf Millin Company, Toronto. He was formerly wit the Dominion Live Stock Branch at Charlottetown, P.E.I.

J. A. Gray (O.A.C. '22) is now with th Sun Life Assurance Company at Regina Sask.

IMPORTANT

Many members have suggested that the personal notes appearing in this section of the magazine might be considerably extended. I has been the practice, in former issues, to publish any news coming to the General Secretary's attention, directly or indirectly, during the preceding month. Members are frequently urged, through these pages or in some other way, to send to the General Secretary any change in their position or address, and if each member will make a point of doing that one thing, this interesting feature of the magazine can very quickly be enlarged.

ARTICLES

Another and more serious problem is the one of securing suitable articles for the magazine. We frequently receive criticisms from members who ought to be contributing instead of criticizing It is obvious that the tastes of all members cannot be satisfied, but if more articles were submitted we could more nearly approach the desired goal. The present issue is largely made up of what might be considered as popular material, with the single exception of a short article by Dr J. S. Shoemaker. The next issue, we can now promise our readers, will be vastly more technical.

Much as we desire to satisfy the literary tastes of each member of the Society, we are obliged to prepare each issue from the comparatively small choice of material available having in mind that many technical articles should be given prompt publication in order that the author may receive priority of credit for the work described.

Factors Affecting the Productivity of Western Canadian Soils.

F. A. WYATT

Soils Department, University of Alberta, Edmonton, Alberta.

In order to understand the different pro-ictive powers of various soils in Western ınada it is necessary to keep in mind the ctors and forces which have been and are ll affecting the physical, chemical and bio-gical constitution of these soils. The fac-rs which have left their imprint in these ils are in general the same factors which ıve produced the present soil conditions in rious parts of the world—but through the orld different individual factors have ex-ted varying degrees of influence upon the ils of the respective regions. Thus the fact at the soils of Western Canada differ in eir respective abilities to produce crops is ıe to the degree of influence exerted by one several of the various factors which are sponsible for the formation, distribution ıd modification of the soil mass.

These factors may briefly be grouped as llows: lithological, weathering and dis-ibution agencies, climate. Each of the ove groups may be further divided into veral factors.

Before proceeding to the discussion of soil fferences caused by the above named fac-rs it might be worth while to draw atten-on to the physiographical features which ıaracterize the Western Canadian plains. hese plains may be said to extend from the ıse of the Laurentian Plateau to the foot-lls of the Rocky Mountains. They cannot y any means be considered as one continu-ıs belt of similar topography, material or evation, but rather a series of plains, in-easing in elevation toward the west.

Each plain is somewhat irregular owing to ıe prominent elevations, depressions, and ainage systems. Within the boundaries of ıch plain is to be found prominent physi-l features such as hills, plateaus, erosion urses, lakes, moraines, etc.

More detailed descriptions of these plains ay be found in various publications of the Canadian Geological Survey by Dawson (2), Dowling(3), and also by Dr. Shutt(7). The above authors arrange this part of Western Canada in a series of three great plains.

The west or highest plain begins at the foothills of the Rocky Mountains and extends eastward to the excarpment of the Missouri Coteau. It includes all of Alberta and a considerable part of western and southwestern Saskatchewan.

A more definite statement of the Eastern boundary of this plain may be as follows: Beginning at Fort McMurray on the Athabaska River; Tp. 89, Rge. 9 west of the 4th., it proceeds almost due south to the Beaver River, about Tp. 62, Rge. 10, west of the 4th.; thence slightly south of east following closely the course of this river to a point in Saskatchewan, about Tp. 59, Rge. 15 west of the 3rd. Thence south eastward to Blaine Lake, a point about halfway between North Battleford and Duck Lake. Thence it bends south westward through Biggar, thence south eastward on the north of Lake Johnston and to the boundary line just east of the 104th Meridian.

The middle plain has its western boundary on the Missouri Coteau as above outlined, and its eastern boundary line as follows. Beginning in the north of Manitoba at about the 100th Mer. it proceeds south westward to the Saskatchewan River, thence northeast around the Pasquia Hills, thence south eastward to the east of Porcupine mountain through Daughin and Morden on to the boundary. This second plain occurs largely within the province of Saskatchewan. It extends into the north eastern part of Alberta and the north western and southwest parts of Manitoba.

The eastern plain has its western boundary as above described, and its eastern boundary is the base of the Laurentian excarpment. It occupies chiefly the Red River Val-

ley together with the Lake regions of Manitoba.

The average elevations of the various plains would be respectively 800, 1600 and 3000 feet for the east, middle and western plains. The surface appearance is most uniform for the east plain and least uniform for the west plain. The reason for this difference in topography will be brought out later in the discussion.

There is to a certain extent a uniformity within the soils of the respective plains conforming to the uniformity in topography. This is to be expected when it is understood that the agencies which have weathered and distributed the soil materials are the agencies chiefly instrumental in producing the topography. Thus the soils of the eastern plains are found to be more uniform than the soils of the middle plain, and this in turn possesses more uniformity in soil types than does th western plain. The soil of the eastern plai are more largely the result of lacustrine co ditions than those of the other two plain whereas the soils of the middle and wester plains are more largely influenced by glaci tion and erosion agencies. These agencie as will be seen later, have caused great va iations in the soil types.

Lithological Factors

The lithological factors, that is the pare materials from which the soils have bee formed, are likewise somewhat different fo the different plains as well as for differen areas within the same plain.

The parent rocks such as granite, feldspa silicates, dolomites, limestones, sandstone shales, etc., exert a characteristic influence u on the productivity of soils formed fro them. Thus some materials when weathere

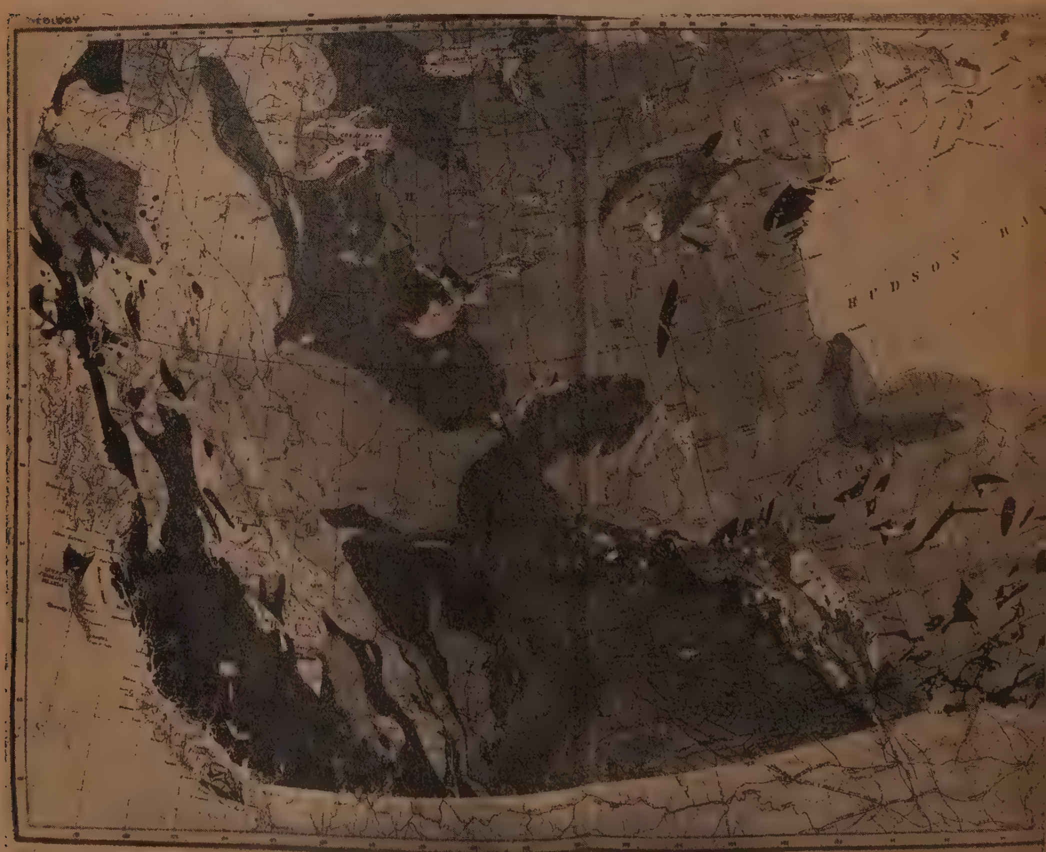


Fig. 1—Geological Map of Western Canada (from Atlas).

into a soil mass are very fertile while others are barren. Some such rocks form soils acid in reaction, others produce soils alkaline in reaction while still others produce soils neutral in reaction. Some form soils extremely coarse in texture, whereas others form soils extremely fine and tenacious in texture. Again some parent rocks weather into soils possessing a high content of soluble salts, whereas others chiefly give rise to soils of extremely low soluble salt content.

The shales and sandstones underlying the western Canadian provinces are not the original parent rocks, but rather sedimentary formations resulting from forces which have made rocks from weathered materials. These shales and sandstones have been largely influenced by water separation and mixing before being pressed into the present rock materials. Some have been deposited under fresh water conditions whereas others have been laid down under brackish or even saline conditions.

With this brief statement regarding the formation of the underlying shales and sandstones it is quite readily understood why certain formations should contain certain substances not found in other formations; why the weathered shales in some instances should be extremely clayey and why in other instances extremely sandy. The shales in many cases contain a very high content of fine and very fine sand while the sandstones often contain appreciable quantities of silt and clay. Some of these formations may be highly calcareous whereas other may even be devoid of carbonate materials. In instances where these parent materials are permitted to weather in place, undisturbed by external agencies, the result is that the shales form a rather uniform soil generally heavy in texture, and difficult to cultivate but well supplied with most mineral plant foods whereas the sandstones form a uniform soil usually very light in texture and easy to work but not so well supplied with some of the mineral plant foods. The weathering of these sandstones generally give rise to soils high in limestone, whereas the shales are often either deficient or even devoid of free carbonate materials This fact again further tends to intensify the heavy nature of the shale soils, and the light nature of the sandy soils. These differences in composition due to the parent material will be noted later in connection with table 7.

On the plains of Western Canada it is rarely found that truly residual soils occur, (except in limited areas) not because of the fact that soils have not been formed *in situ* but rather because outside agencies have caused considerable mixing and rearranging of the local materials with materials brought in by ice and water. This invasion of outside material has had a very great influence upon both the texture and structure of the soils. It is due to these agencies of weathering and distribution that the soils of the middle and western plains, especially the western plain, are not extremely uniform in texture and structure. These agencies are likewise responsible to a great extent for the generally abundant supply or mineral plant foods.

Weathering and Distribution Agencies

The weathering and distribution factors have been chiefly ice, water, wind, and decomposition due to chemical and biological agencies. They have been responsible for the wearing away of the country rocks, the carrying in of outside drift, the transportation, mixing and assorting of the local material. It is due to these agencies that we find in some areas of the plains well assorted and uniform materials whereas in other areas we find imperfectly mixed and thoroughly non-uniform soils. The geologist undoubtedly considers the soil materials of these plains well assorted and in the main very uniform. However, when we study in detail the nature of the various soil types within any district we find generally that within the boundaries of each soil type there occur many irregularities and that after all the soils of the glacialed areas are much less uniform than those of the lacustrine or loessal districts.

In general we may safely state that the entire areas of these plains have been subjected to glaciation, the only exceptions being in cases where the initial plains were above the elevation of the various ice thrusts, examples of which may be mentioned, such as the Cypress Hills, Hand Hills, and Swan

Hills in Alberta. These hills have an elevation slightly greater than 4000 ft. above sea level, or approximately the elevation of Banff. They show no distinct evidence of ever having been covered with the glacial ices, but glacial material surrounds these hills and is often encountered well up on the slopes of the escarpments. The tops of these initial table lands consist of material distinctly different from the surrounding territory. In fact the soils on these hills consist of true residual material resulting from the weathering of the conglomerate which caps them. Where such material has been transported by water it materially influences the character of the adjoining soils. Such is the case between the South Saskatchewan River Basin in south eastern Alberta, and the Cypress Hills.

Glacial drift covers the surrounding plains to a depth of from a few inches to several hundred feet, except in very small areas of residual soils, or in areas where extensive reworking and redistribution of the materials have been brought about by such agencies as streams and lakes. The drift is found to be shallow on the pre-existing plateaus and deep in the pre-existing valleys. Numerous moraines are found scattered over the plains, some small and others large. As an example, an immense moraine occurs practically along the Saskatchewan, Alberta boundary line, and ground morainal material covers an area at least 20 to 35 miles wide in Alberta, and at least 15 miles wide in certain adjoining parts of Saskatchewan.

The soils of this district are characterized in general by their decided lack of uniformity. But as one proceeds away from the chief moraines more uniformity in soil types is found. This is the result of reworking and assorting of the materials by the post-glacial waters such as streams and lakes

The main drift covering these plains has been brought in by the Keewatin glaciers. This drift covers practically all of the prairie provinces, and extends well to the south of the boundary line. However, the soils of the extreme western part of Alberta are influenced by glaciers from the Rocky mountains and between the fronts of the Keewatin and Cordilleran glaciers the soils are materially different from the soils of the middle and eastern plains in that they contain greater admixtures of quartzite and limestone materials.

Drainage Agencies

The drainage agencies have further eroded and modified the conditions of the drift material. From the plains of western Canada the drainage is delivered into three different ocean waters.

The drainage from a small portion of southern Alberta is carried through the Milk River to the Missouri and thence to the Gulf of Mexico; that from the south central parts of Alberta and Saskatchewan through the Saskatchewan River to Hudsons' Bay; whereas that from the northern parts of Alberta and the north-western part of Saskatchewan finds its way through the Mackenzie River to the Arctic Ocean.

The present and post-glacial river basins have exerted considerable influence upon the soil relationships of these plains, especially the western and, to a somewhat lesser extent, the middle plain. They have eroded the plains and carried away much of the material thus formed together with that from the glacial drifts, and rearranged it with respect to their courses. Thus we find large areas of fairly well assorted sands occupying positions relative to the river courses.

Likewise the fine silts and clays have been deposited in the quieter waters of the lakes which accompanied these drainage systems.

There was considerable, but by no means complete assorting of the soil materials by the interglacial and post-glacial waters, but after the main quantities of water had drained away from the ice sheets, the further separation of materials was confined to the alluvial plains of the rivers and the shores and beds of the lakes connecting those drainage ways. There are still numerous lakes constituting part of the present drainage courses of these rivers. For instance the series of lakes between the headwaters of the Athabaska and Peace Rivers, and the outlet of the Mackenzie River. Moreover there are many lakes of glacial and post-glacial origin, which are only remotely connected with the main drainage courses of the rivers.

The prevailing winds have likewise, to a certain extent, functioned as agents in rearranging the soil materials of these plains. After the waters from the glaciers had subsided and before the vegetation had covered the surface material the winds caused the movement of soil materials. Thus the sand along the river courses and lake shores was in many instances heaped into dunes. The finer material was carried farther to the leeward and we find a succession of sandy soils followed by sandy loams and then by silt loams. This same succession is often encountered in relation to the glacial moraines and the drainage form them, but has been caused by waters. After vegetation covered the plains the wind action was confined only to local areas of expecially the sandy soils. The wind action also carried salts from the dry beds of lakes and distributed them over the soils, in some instances the same soils from which they had been washed by percolating waters. However, in general, it may be said that the plains of Western Canada do not contain extensive areas of uniformily loessal material such as is found on the prairies of Iowa and Illinois.

From the above statements it can readily be understood why the soils of these plains are not entirely uniform as to texture and structure or even as to chemical constitution. There occur certain areas of relatively uniform material separated by less thoroughly assorted soils and interspersed with alluvial soils, lacustrine soils, terminal and ground moranial materials, small areas of residual soils and stony outcrops. There are great differences in the soluble salt content of these soils. On the whole they are well supplied with the mineral plant foods, but in certain areas they tend to be low in phosphorus and in some cases they are neutral, or even distinctly acid in reaction. A more specific difference in composition is shown by the data in Table 7.

Climatic Factors

The climatic factors of these plains have on the whole exerted more influence upon the present productive power of the various soil types in various districts than have the lithological or weathering agencies, in that the factors of climate have been responsible for the nitrogen and organic matter content of the various soils. The climate of these plains may be characterized by the dry cold winters during which no growth occurs and accompanied by at least partial sterile conditions—i.e. micro-organic activity, followed by the slow advancement of spring and the rapid advancement of summer, accompanied by high daily temperature with long hours of sunshine and generally sufficient moisture to enable rapid preparation of plant foods and astonishing crop growth. The season between frosts varies from about 100 to 130 days for various years and various parts of these plains. The total rainfall is on the whole rather light, but owing to the fact that at least 75% of it falls between April 1st and Oct 31st during the growing season, it is more efficient in producing crops than would be the case provided a greater proportion occurred during the fall and winter seasons. Thus we see that the climatic conditions favour intensive and rapid growth for a period of the year coinciding with the greatest rainfall, followed by dry cold weather which delays and often almost immediately prevents the decomposition and loss of organic matters and plant foods, until the following spring when temperature and moisture again permit the rapid preparation of food for plants at a time when they are in greatest demand. The above conditions have been responsible for the present vegetation covering these plains and this native vegetation has been responsible for the nitrogen and organic matter content of the soils. From the standpoint of natural vegetation these plains may be subdivided into three main regions. First, the prairie areas which are virtually devoid of trees and contain chiefly the short grasses. These areas coincide in general with the districts of lowest rainfall. Second, the park areas which are really the districts of mixed prairie and small bush, such as willows. These areas occur adjacent to the prairie districts. Third, the wooded areas, which in general occupy the districts of greatest rainfall. (See Figure 2).

Fig. 3 shows the main areas occupied by each of the three above named divisions for the province of Alberta. A rainfall map would in the main have lines closely related

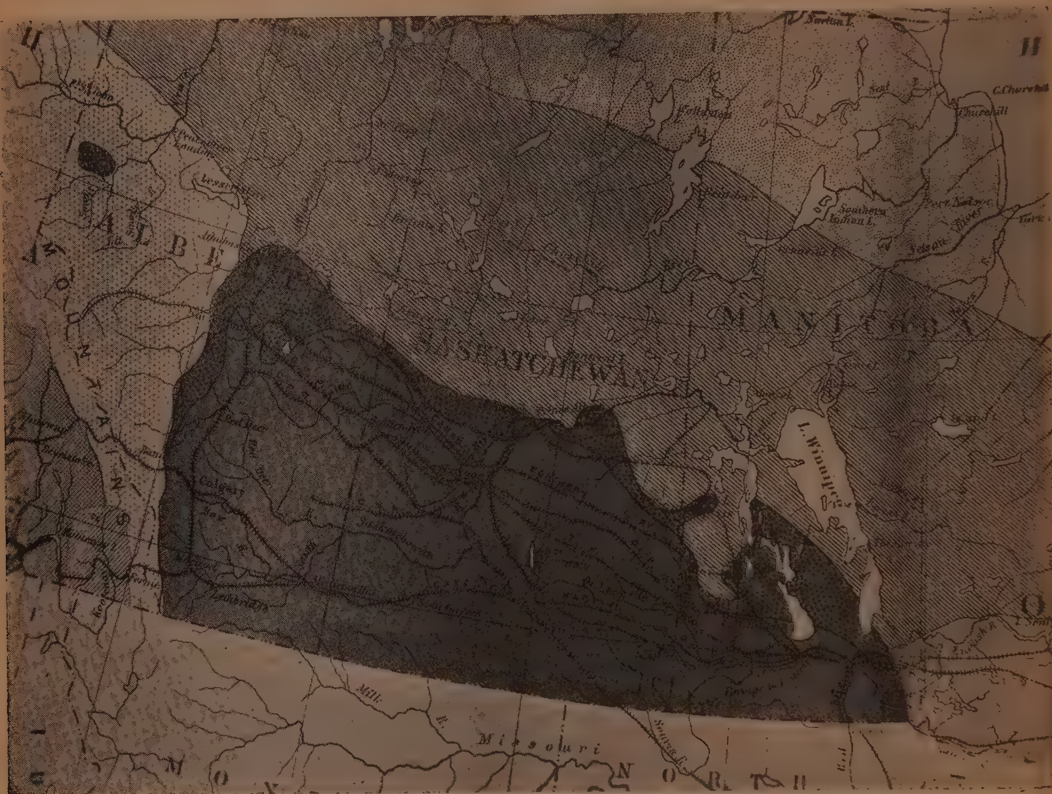


Fig. 2—Forests of Western Canada (from Atlas).

to the native vegetation areas since the amount and efficiency of the rainfall has been the chief factor in causing the present conditions of vegetation. A production map would likewise be closely related to these same areas. However, the rainfall and production areas would somewhat overlap the vegetation areas owing to the fact that the districts of lightest rainfall have the longest growing season, and the highest rate of evaporation. Again there are certain local features such as topography and soil type which influences the nature of the initial vegetation and the efficiency of a unit of rainfall. Thus we find that district No. 1 (Fig. 3) is chiefly a short grass district with lower annual rainfall and less efficiency per unit than either districts No. II, or No. III. The soils of this district are in general lighter in color, and somewhat earlier in maturing the crop. They supply less nitrogen to the crop during the season than do the soils in the other districts. When the season is right they produce a higher quality in the wheat than can be obtained from the other districts. In facts it is from the better parts of the dryest districts that the greater number of our prize winning wheats are grown.

District No. II has areas of mixed short and long grasses and areas of small bush and willows whereas district No. III is chiefly a long grass area heavily wooded for the most part. The distribution of rainfall is virtually the same for each ditsrict, the amounts and efficiency is least for district No. I and greatest for district No. III. The same relationship holds for the provinces of Saskatchewan and Manitoba. However, in general, the rainfall is greatest as the series of plains extent to the eastward from the Rocky Mountains. This is especially so across the southern parts of the prairie provinces, but for the middle and western plains the rainfall increases as we proceed northward. Or we might say that the rainfall increases in three

Fig. 3—Vegetation Map of Alberta.

lirections, north, east and west, from the entre of lowest precipitation (south eastern lberta and south western Saskatchewan).

Proceeding from the south to the north, imilar variations in the annual rainfall are be found as a feature of each of the plains rrespective of their general elevations. This indicated by the fact that similar variaons in grass coverings and soil colors are nuch the same for each of the three plains. However, the eastern plain is under a heavier rainfall than either the middle or western plain. The region of lowest rainfall covers a large part of southern and eastern part of Alberta, the western and southern part of Saskatchewan and a very small part of the south western corner of Manitoba. It is an extension of the climatic region of the states to the south of the boundary line between the Rocky Mountains and the Dakotas. As

TABLE 1. SEASONAL DISTRIBUTION AT MACLEOD, PRECIPITATION IN INCHES YEARS 1895-1914

Month	PRECIPITATION Average Monthly Fall	Greatest Amount in one month	Total Amt. in driest Year 1904	Total Amt. in wettest year 1911	SNOW Average Monthly Fall	Greatest amount in one month
December	.51	2.00	.28	.70	5.1	20.0
January	.72	3.22	0.00	1.20	7.2	32.2
February	.59	1.75	T	1.15	5.8	17.5
Winter	1.82	—	.28	3.05	18.1	—
March	.68	1.77	.90	.70	6.4	17.7
April	.50	1.33	.10	.45	2.7	13.3
May	1.98	6.56	.55	2.76	.9	6.0
Spring	3.17	—	1.15	3.91	10.1	—
June	2.88	6.83	.65	4.61	—	—
July	1.85	4.13	.65	2.77	—	—
August	1.52	4.04	1.36	2.79	.15	3.0
Summer	6.26	—	2.66	10.17	.3	—
September	1.15	3.14	.90	3.14	.9	13.0
October	.55	2.46	.35	.34	3.8	24.0
November	.64	2.20	0.00	.63	6.0	22.0
Fall	2.35	—	1.25	4.11	10.8	—
Year	13.60	—	5.34	21.24	39.2	—

early as 1857 Palliser (6) outlined this area of low rainfall as follows:

"This central desert extends, however, but a very short way into the British territory, forming a triangle, having for its base the 49th parallel of longitude 100° to 114° W., with this apex reaching to the 52nd parallel of latitude". In other words the triangle would include the territory within the following boundaries: From the foothills of the Rock Mountains along the 49th parallel across Alberta, Saskatchewan, and about one quarter the way across Manitoba; thence north west to Coronation in Alberta, thence south west to the foothills of the Rocky Mountains.

As previously stated the efficiency of rainfall is affected by its distribution together with the ability of the soils to absorb and retain it, and subsequently to give it up to the crop rather than permit it to be lost by evaporation. The prevailing winds and lack of vegetation on the treeless plains cause higher evaporation than occurs in the park belt.

The effects of these climatic factors upon the production of crops may more clearly be shown by tabulating the data on the amount and distribution of rainfall, the frost free periods, the mean and extreme temperatures, and the yields of the most important crop—wheat. Several of the following tables are taken from the Soil Report (10) of the Macleod Sheet, Alberta.

Table I, compiled from the Dominion Meteorological Records (1), shows the average seasonal distribution of precipitation for a period of twenty years at Macleod. This seasonal distribution is representative of the entire sheet. For the annual precipitation see Table II.

From Table I, it may be seen that about 46 per cent of the average annual rainfall at Macleod for the 20 year period 1895-1914, fell during the summer months; that the growing season, May, June, July and August, received at least 60 per cent of the yearly rainfall, and that 72.6 per cent fell during the months of April to October inclusive. Such a favourable seasonal distribution of the rainfall is decidedly more effective in producing crops than a similar annual precipitation would be, provided it

[T]ABLE 2 — PRECIPITATION RECORDS FOR MACLEOD, LETHBRIDGE AND MEDICINE HAT, 1904-1922.

	RAINFALL IN INCHES		
[Y]ear	Macleod	Lethbridge	Medicine Hat
[1]904	5.34	11.30	9.70
[1]905	11.63	13.78	8.99
[1]906	21.82	22.48	12.62
[1]907	12.36	15.50	6.86
[1]908	18.13	16.37	10.22
[1]909	15.01	11.69	9.78
[1]910	9.82	7.97	7.55
[1]911	21.24	21.28	16.24
[1]912	13.73	13.21	10.38
[1]913	10.76	14.17	13.62
[1]914	20.50	17.58	12.17
[1]915	22.92	17.40	16.13
[1]916	24.45	25.92	17.90
[1]917	14.43	11.87	11.13
[1]918	9.70	8.94	10.19
[1]919	12.39	13.36	7.66
[1]920	15.00	14.05	10.74
[1]921	13.46	12.13	11.74
[1]922	16.50	13.22	11.34
[A]verage	15.22	14.85	11.32

[w]ere more largely distributed over the win[te]r and early spring seasons.

It may be noted that there occur great [d]ifferences in the annual rainfall, as that [o]f the driest season is only one fourth that [o]f the wettest season. This fact may be fur[t]her explained by referring to Table 2. [T]here is as much proportional variation in [t]he distribution of the snowfall as for the [r]ainfall, and the soils of this plain are often [l]eft bare for long periods during the winter [m]onths, which permits them to dry out and [o]ccasionally blow badly.

The precipitation often occurs in the form [o]f intermittant showers in which case it is [n]ot the most effective. While we have not [s]ufficient data to enable us to state positive [c]onclusions, it appears evident from the na[tu]re of the soils and the amount of organic [m]atter found in them, that the greatest pre[c]ipitation area of the entire dry district is [t]he western part especially near the foot[h]ills.

Rainfall records have been kept at Macleod since 1896, at Lethbridge since 1902, and at Medicine Hat since 1885. Medicine Hat is about 60 miles east of the eastern boundary of the Macleod Sheet but precipitation data from this point have been included in Table 2, for purposes of comparison.

Yields for the principal crops of this sheet date back only to 1905, therefore precipitation data from the above three points only since 1904 are reported here.

From Table 2, it may be noted that, for the three points mentioned, during the wettest year there was from two to four times as much rainfall as during the driest year. During the nineteen years, 1904-1922, the rainfall at Medicine Hat exceeded that at Lethbridge only in 1918 and that at Macleod in 1904, 1913 and 1918. Furthermore that in six out of nineteen years at Medicine Hat the annual rainfall was less than 10 inches as compared with two years at Lethbridge and three years at Macleod.

When the annual precipitation is below a certain minimum it is almost impossible to produce a crop for that year and what little rainfall does come has a very low efficiency factor.

The frost free periods have a considerable bearing upon the risk in producing certain of the farm crops, and usually we may expect the time taken to mature the crop to be longest during the wettest years; thus the danger from frost would be increased for the wettest years. The data for frost-free periods is found in Table 3.

Reference to Table 3 will show that the average length of the frost-free period for the 20 years from 1902 to 1921 was 106 days at Lethbridge, and 125 days at Medicine Hat. At Macleod the average length of the frost-free period for the 15 years from 1902 to 1917 was 105 days.

July was the only month entirely free from frost at all three places during the period of years referred to. The shortest frost-free period in any one year, at any one of the three places, was 41 days; this short period occurred at Macleod, in 1906. The next shortest period occurred at Lethbridge in 1902; it was 70 days. The longest frost-free period at Lethbridge was 132 days, at

TABLE 3—FROST-FREE PERIODS

Year	LETHBRIDGE	days	MACLEOD	days	MEDICINE HAT	days
1902	June 20-Aug. 29	70	June 19-Aug. 29	71	May 5-Aug. 20	107
1903	May 22-Sept. 13	114	—— Sept. 2	—	May 21-Sept. 16	118
1904	May 25-Sept. 13	111	June 6-Sept. 12	96	May 25-Oct. 5	133
1905	June 23-Sept. 30	99	June 24-Sept. 15	83	May 19-Sept. 30	134
1906	May 30-Aug. 25	87	June 23-Aug. 3	41	May 7-Sept. 12	127
1907	May 13-Sept. 11	121	June 3-Sept. 11	100	May 13-Sept. 18	128
1908	May 14-Sept. 23	132	May 2-Sept. 23	144	May 1-Sept. 24	146
1909	May 19-Sept. 14	118	May 18-Sept. 14	119	May 8-Sept. 23	138
1910	June 3-Aug. 24	82	May 4-Sept. 9	128	June 3-Sept. 12	101
1911	May 28-Aug. 27	91	May 28-Sept. 21	116	May 1-Sept. 22	144
1912	June 6-Sept. 6	92	June 6-Sept. 15	101	May 12-Sept. 2	113
1913	May 15-Sept. 12	120	May 16-Sept. 7	114	May 6-Sept. 20	137
1914	May 12-Sept. 15	126	May 13-Sept. 20	130	May 12-Oct. 5	146
1915	May 16-Sept. 11	118	May 16-Sept. 11	118	May 6-Sept. 13	130
1916	June 1-Sept. 14	105	May 25-Sept. 14	112	May 16-Sept. 14	121
1917	June 4-Sept. 1	89	May 30-Sept. 5	98	May 30-Sept. 5	98
1918	June 1-Sept. 15	106	——	—	May 9-Sept. 9	123
1919	June 1-Sept. 29	120	——	—	May 7-Sept. 28	144
1920	June 2-Sept. 27	117	——	—	June 1-Sept. 26	117
1921	May 28-Sept. 9	104	——	—	May 28-Sept. 10	105
Average		106		105		125

TABLE 4.—TEMPERATURES: MONTHLY, SEASONAL AND ANNUAL MEANS AND EXTREMES AT MACLEOD, ALBERTA, 1905-1914

MONTH	TEMPERATURE Mean	Mean Maximum	Mean Minimum	Highest Monthly Mean	Lowest Monthly Mean	Extreme Highest	Extreme Lowest
December	23.1	32.8	13.4	30.5	9.6	59	–35
January	14.0	25.5	2.6	26.3	3.8	60	–45
February	19.2	30.8	7.6	28.8	10.2	62	–49
Winter	18.8	29.7	7.9	——	——	62	–49
March	29.2	41.4	17.0	42.2	21.3	82	–33
April	42.5	55.5	29.4	50.6	34.3	89	3
May	48.9	60.8	37.1	52.6	44.9	88	19
Spring	40.2	52.6	27.8	——	——	89	33
June	58.6	71.4	45.8	63.8	54.7	99	30
July	64.0	78.5	49.5	67.4	59.7	102	35
August	61.3	75.8	46.7	65.7	57.2	99	29
Summer	61.3	75.2	47.3	——	——	102	29
September	53.4	66.4	40.4	58.0	48.5	91	18
October	43.9	55.8	32.0	50.3	40.1	81	– 4
November	32.3	42.1	22.6	37.7	21.2	68	–24
Fall	43.2	54.7	31.7	——	——	91	–24
Year	40.9	53.1	28.7	——	——	102	–49

Macleod 144 days, and at Medicine Hat 146 days. In only 6 years out of 20 was the frost-free period less than one hundred days at Lethbridge; in only five years out of fifteen at Macleod, and only one year was the frost-free period less than one hundred days at Medicine Hat. It should be noted also, that the frost-free period is not usually as long as the growing season for wheat and many other crops. As a rule the earliest fall frosts are too light to damage the ripening wheat, and late spring frosts seldom affect the wheat crop seriously.

It should be further noted that Sept. 13, 1903, is the earliest date at which more than one degree of frost occurred at Lethbridge. On Sept. 5, 1917, two degrees of frost occurred at Macleod, but on all other earlier dates not more than one degree of frost was experienced. June 6, 1912, is the latest date at Macleod reporting more than one degree of frost, but even for this year the frost-free period was 101 days. Even, at Macleod, in 1906 when the frost-free period was only 41 days the temperature on June 23, was 33 degrees and that on Aug. 3 was 31 degrees.

As previously stated, the climate of the plains area is subject to great extremes of heat and cold together with a high proportional amount of bright sunshine and occasional high winds. An idea of the variations in temperature may be obtained from Table 4, taken from the Dominion Meterological Records for the years of 1905 to 1914.

The distribution and amount of annual rainfall are the two greatest factors in the production of crops on the plains of Western Canada. By taking the total rainfall as given in Table 2, and the amount for May, June, July and August together with the rainfall of the previous September and October, we may make direct comparisons of the distribution and total rainfall. This together with the yields of wheat (the most important crop for Western Canada) for the 18 years for which we have records at three points mentioned, is shown in Table 5.

The average yields of wheat for the following three constituencies are 17.40, 17.38 and 13.43 bushels respectively for Macleod, Lethbridge and Medicine Hat, while the average annual rainfalls are 15.22, 14.85 and 11.32 inches respectively. The extreme variation in yields is from less than three to more than 43 bushels, whereas the extreme variation in annual rainfall is from a little more than 5 to about 26 inches.

The lowest yield does not always occur during the season of lowest rainfall neither does the highest yield occur during the season of greatest rainfall, otherwise 1916 should have shown the highest yield.

Other factors mitigate against such absolute harmony between rainfall and yields. A succession of either wet or dry years together with the monthly distribution of rainfall, severe frosts, and crop diseases have their effects upon crop yields.

However, in general the seasons of low rainfall are the seasons of low yields and likewise the seasons of high rainfall are the seasons of high crop yields. A better idea of the relationship between rainfall and yields may be obtained by referring to Figure 4 in which the data of Table 5 are plotted as curves.

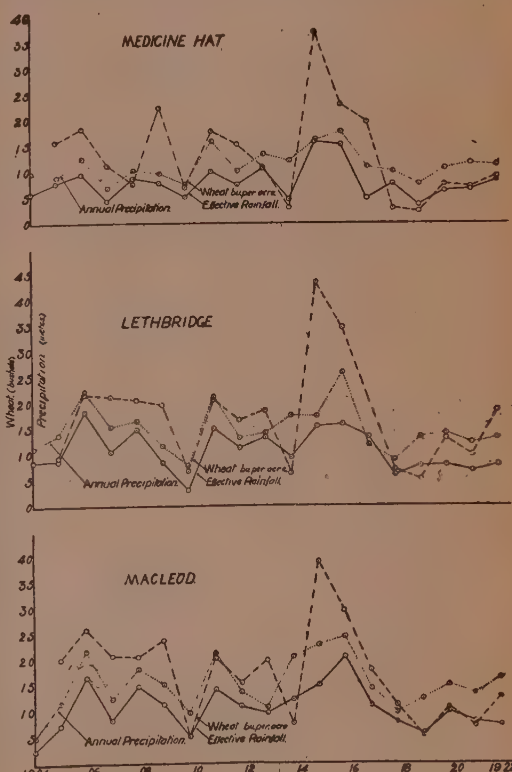


Fig. 4—Relation between Rainfall and Wheat Yields for Southern Alberta (18 years).

TABLE 5—YIELDS SEASONAL AND ANNUAL PRECIPITATIONS, 1904-1922.

	MACLEOD				LETHBRIDGE				MEDICINE HAT			
Year	Yield per acre, wheat: bushels	Precipitation previous Sept. & Oct.	Precipitation May, June, July, Aug.	Annual Precipitation	Yield per acre, wheat: bushels	Precipitation previous Sept. & Oct.	Precipitation May, June, July, Aug.	Annual Precipitation	Yield per acre, wheat: bushels	Precipitation previous Sept. & Oct.	Precipitation May, June, July, Aug.	Annual Precipitation
1904	——	.35	2.81	5.34	——	1.77	6.81	11.30	——	.70	5.25	9.70
1905	20.13	1.25	6.07	11.63	9.43	1.37	7.44	13.78	15.87	1.20	6.65	8.99
1906	26.04	1.68	15.04	21.82	21.79	1.93	16.44	22.48	18.66	.29	9.26	12.62
1907	20.75	1.24	7.20	12.36	21.34	2.09	8.51	15.50	11.36	.49	3.88	6.86
1908	20.50	1.96	12.90	18.13	20.69	3.29	10.88	16.37	7.68	1.01	7.83	10.22
1909	23.78	1.48	9.83	15.01	19.75	1.35	5.27	11.69	22.80	1.22	6.74	9.78
1910	5.22	.52	4.72	9.82	6.77	.84	2.49	7.97	7.02	.55	4.65	7.55
1911	20.32	1.37	12.93	21.24	20.70	2.59	12.51	21.28	18.23	.84	9.29	16.24
1912	15.48	3.48	7.58	13.73	16.71	4.71	6.58	13.21	15.58	2.20	5.38	10.38
1913	19.89	2.53	7.19	10.76	18.57	3.68	9.62	14.17	11.11	2.22	8.56	13.62
1914	7.68	.72	11.49	20.50	6.31	2.15	7.28	17.58	3.21	1.21	3.55	12.17
1915	39.07	2.84	12.18	22.92	43.61	3.24	12.27	17.40	37.48	4.88	11.17	16.13
1916	29.49	5.71	14.87	24.45	34.69	2.28	13.61	25.92	23.33	3.18	12.21	17.90
1917	18.00	5.71	5.43	14.43	——	7.65	5.74	11.87	20.00	1.68	3.25	11.13
1918	11.16	2.96	5.00	9.70	7.05	2.44	3.47	8.94	2.99	2.68	6.08	10.19
1919	5.32	1.49	4.24	12.39	5.15	2.19	5.50	13.36	2.36	.62	2.97	7.66
1920	10.67	3.85	6.88	15.00	13.02	3.82	4.85	14.05	7.73	1.44	5.02	10.74
1921	7.02	1.13	6.84	13.46	9.77	1.04	5.69	12.13	7.16	1.28	5.40	11.74
1922	12.70	1.26	6.01	16.50	18.50	1.52	6.34	13.22	9.25	2.22	6.05	11.34
Ave.	17.40	2.19	8.4 0	15.22	17.28	2.63	7.96	14.85	13.43	1.57	6.48	11.32

The yields of wheat and the annual rainfall figures are taken from Table 5. The effective rainfall is the rainfall of May, June, July and August plus that of the previous September and October. In general the yield curves go up and down with the rainfall curves but for the better years the yield curves rise more rapidly than the rainfall curves, and for the drier years the yield curves fall more rapidly than the rainfall curves. Thus a unit of rainfall is less efficient in producing crops during the extremely dry years than the wetter years.

There is a bit closer correlation between the yield curves and the effective rainfall curves than between the yield curves and the annual rainfall curves. The nineteen years averages of effective rainfall at the three points mentioned are 10.59; 10.59; and 8.05 respectively for Macleod, Lethbridge and Medicine Hat.

A still more detailed comparison between the monthly distribution of rainfall and the crop yields may be made. Such a comparison for Macleod only is shown in Figure 5.

As previously pointed out, during the drier seasons the economic efficiency of a unit of rainfall is generally comparatively low, since the rainfall during such seasons is sufficiently low to materially reduce or even almost inhibit the maturing of crops. By dividing the yield figures in Table 5 by the rainfall figures for the corresponding year we obtain figures representing the bushels of wheat produced for each inch of rainfall. Such values for the 18 years reported in Table 6.

The only great discrepancy in the entire table is for the year 1914, when we may have justly expected somewhat greater yields. The average number of bushels of wheat produced by each inch of rainfall is virtually the same at all points; in fact the agreement is remarkably close. However there is a great amount of variation from season to season, the drier years produced only about .3 to .5 bushels per inch of annual rainfall whereas

TABLE 6—WHEAT BUSHEL PER ACRE, PER INCH OF RAINFALL

	MACLEOD		LETHBRIDGE		MEDICINE HAT	
	BU. PER INCH		BU. PER INCH		BU. PER INCH	
Year	Effective Rainfall	Annual Rainfall	Effective Rainfall	Annual Rainfall	Effective Rainfall	Annual Rainfall
1905	2.75	1.73	1.07	.68	2.02	1.76
1906	1.56	1.20	1.10	.97	1.95	1.48
1907	2.46	1.68	2.01	1.38	2.60	1.65
1908	1.37	1.13	1.46	1.27	.85	.75
1909	2.10	1.58	2.98	1.69	2.86	2.33
1910	1.00	.53	2.02	.86	1.35	.93
1911	1.42	.96	1.37	.97	1.80	1.12
1912	1.40	1.13	1.40	1.26	2.05	1.50
1913	2.04	1.85	1.39	1.31	1.03	.81
1914	.63	.38	.60	.36	.67	.26
1915	2.60	1.70	2.81	2.51	2.33	2.32
1916	1.43	1.21	2.20	1.30	1.51	1.30
1917	1.61	1.25	—	—	4.05	1.80
1918	1.40	1.15	1.20	.79	.34	.29
1919	.93	.43	.68	.39	.66	.31
1920	.99	.71	1.50	.92	1.20	.72
1921	.88	.52	1.45	.80	1.07	.61
1922	1.60	.77	2.35	1.40	1.11	.81
Ave.	1.57	1.11	1.51	1.11	1.63	1.15

POUNDS OF WATER REQUIRED TO PRODUCE ONE POUND OF DRY MATTER

	Macleod	Lethbridge	Medicine Hat
Grain only	3402	3402	3284
Grain and Straw	1701	1701	1642

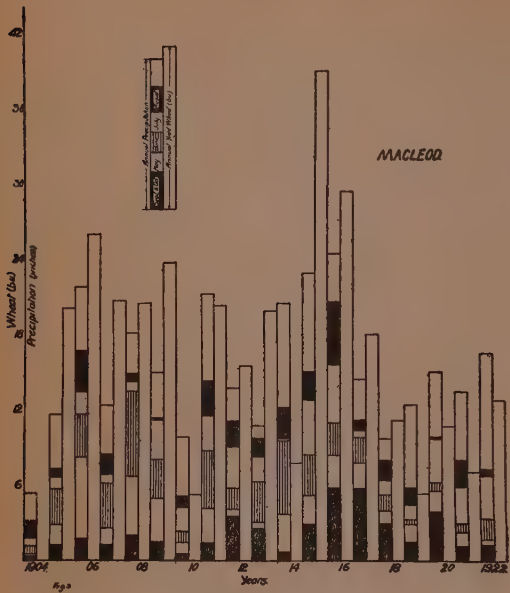


Fig. 5—Yields of Wheat at Macleod, monthly and annual Rainfall.

the better seasons produced as much as 2.5 bushels for a similar unit of rainfall. The effective rainfall has been more efficient than the annual rainfall, but here again there occur great seasonal variations.

From Table 6 it is very evident that during the years of extremely low rainfall the efficiency of a unit of water is much less than during the seasons of average or high rainfall; also that each inch of annual rainfall produced, as an average of 18 years, from 1.11 to 1.15 bushels of wheat, or each pound of wheat (grain only) required about 3366 pounds of water. Now if we assume the yield of straw per acre is equal to the yield of grain we have a water requirement of 1684 pounds for each pound of dry matter.

The figures in Table 6 represent the actual conditions as they exist in the Macleod Sheet according to the present system and methods of farming. This water requirement is undoubtedly too high and the farmer, by better attention to his rotation and fallow practices, should be able to materially reduce it. It represents the evapo-transpiration factor together with the run-off water as actually found under farm practices. A considerable part of the water thus required to produce the crop has been lost by evaporation and run-off.

Soils of Western Canada

As just pointed out the climate conditions very largely determine the agricultural possibilities of any district. However, within any zone of similar climate there are vast differences in the abilities of different soil types to produce crops. These vast differences in the various soil types of the three plains constituting the prairie provinces of Western Canada are due in the main to the factors previously mentioned. In general it may be said that these soils consist chiefly of glacial drift derived largely from the material weathered from the underlying formations, together with varying proportions of materials brought in by the glaciers. These materials may have been completely reworked and separated into uniform heavy and light areas, or only partially reworked leaving intermediate soils of less uniformity.

The greatest amount of separation and reworking of the soil materials occurs in the eastern or lowest plain, and the least amount in parts of the middle and western plains.

The underlying formations are of Upper Cretacious age (See Fig. 1) with the older formations outcropping towards the East. These formations from west to east are Paskapoo, Edmonton, Bearpaw and Belly River. They consist of sandstones, shales and clay, each of which forms a somewhat different soil on erosion. In general the greater part of these plains is covered by glacial drift and boulder clay varying in thickness from a few inches to upwards of twenty feet. The drift deposits have been laid down in greatest thickness in the pre-existing depressions and the main morainal areas, whereas the hills and plateaus are but thinly covered. In fact in a few locations there is no drift covering and the country rock may be seen weathering *in situ*.

In other instances we have encountered the Edmonton Sandstones within two feet of the surface, and the Belly River shales likewise relatively near the surface when soil samples were being taken. The general effect of such glaciation has been a tend-

ency to level up the lower areas and produce a wide flat plain. The reverse action of the waters draining from the glacial ices has been to erode this plain. The greatest amount of erosion has occured on the western or highest of the three plains. The result of the levelling up and the reverse action of erosion has been in general to leave well drained undulating to rolling plains which in not a few instances partake of the nature of hills or plateaus. Aside from the main areas of lacustrine soils much of the glacial material has been only partly assorted and over large areas the drift remains in nearly the same position as when deposited by the melting ice sheets. There is evidence of only a moderate amount of reworking of the materials. Thickly boulder strewn areas are limited and are the result of a subsequent removal of the finer particles by erosion, except in certain locations where boulder hills clearly indicate morainal formations. Where gravel areas occur in general, they occupy the higher parts and are not well separated from other materials. Gravel is promiscuously scattered throughout the subsoils of the higher regions, whereas the subsoils of the lower regions are often lacking gravel indicating that the lower, heavier areas have been laid down by lacustrine waters. However, in some instances even these lower areas show the presence of coarser materials.

The sand areas in general occupy positions relative to the direction of the rivers and drainage ways, especially the main channels running from the melting ice of the glaciers. In certain parts of the sand areas the materials have been subjected to the subsequent action of winds as indicated by the dune areas.

As previously stated the underlying formations consist of sandstones and shales. The sandstones are composed of the finer grades of sand held together by limestone and clay, whereas the shales are often very sandy with clay as the chief binding material. Thus it may be seen that weathering of these country rocks would give rise to soils of intermediate texture, especially since the agencies have later effected only a limited amount of reworking and replacing. These agencies and materials have given rise to a large proportion of the most desirable (medium textured) soils.

It is rather fortunate that such a large proportion of these soils consist of medium textured materials with medium to heavy subsoils, since such soils absorb and retain more moisture than do the lighter soils, and on the other hand respond to tillage more readily than do extremely heavy soils.

The soils of the Canadian Prairies are merely an extension of the soils of the great plains to the south of the boundary, as described by Marbut in Annals of the Association of American Geographers, Vol. XIII, No. 2, June, 1923, from which the following extracts are taken:

"The Great Plains, thus defined, include that part of the United States lying east of the Rocky Mountains, in which the soils are characterized, at maturity of development by (1) the presence, on some horizon of the soil section or profile, of a zone of alkaline salt accumulation, usually, not exclusively, lime carbonate; and (2) a relatively dark colored surface soil. The color varies, from place to place, in degree of darkness but throughout the region it is darker than the mature soil in any other part of the country in which the zone of salt accumulation is present in the soil.

These are the two characteristics that are universally present in the soils of the Great Plains. Neither can be accepted as an exclusive characteristic taken alone, since the dark color of the soils, even of mature soils, is present in regions far beyond the limits of the Great Plains where the salt zone is not present, and on the other hand, the salt zone is present in large sections outside the area of the Great Plains but the dark color of the surface soil is lacking.

The dark color of the soil extends several hundred miles east of the eastern boundary of the Great Plains while the presence of the salt zone extends far west of the region in which the soils are dark in color. The two characteristics, therefore, are not coincident in their distribution, the one extending eastward beyond the area in which both are present and the other extending westward beyond the same area. The region in which the two overlap is designated as the Great Plains.

The position of the Rocky Mountains, along the western boundary seems to be accidental, it being apparent that the western boundary would lie about where it is if the Rocky Mountains were not in existence. This is suggested by the fact that the mountains do not everywhere form the boundary and where absent there is no important deviation of the line from the general course taken by it in places where they are present."

Fig. 6 is adapted from Dr. Marbut's (5) paper as above referred to. The continuation of these soil belts have not been worked out in detail for the prairie provinces of Canada, but the following general statements may be

made with regard to their relative positions. The Black Belt would roughly occupy the Eastern Plain as above referred to, for a distance of at least 100 miles north of the boundary line, where it would tend to swing off towards the north west including the drainage systems of the Carrot River and the North Saskatchewan River in Saskatchewan, thence westward into Alberta along the North Saskatchewan River for a distance of about 100 miles, thence in a direction slightly west of south to a point about 20 miles east of Calgary, then slightly south east including a strip of country about 25 to 40 miles from the foothills and on to the boundary line at a point some distance west of Coutts. This would be the approximate western boundary of the Black Belt. The western boundary of the Brown Belt would begin as indicated by Fig. 6 very near the foothills at the international boundary and proceed northward through a point about 20 miles west of Bassano, thence north eastward through Provost, thence south eastward to the international boundary line at a point well east of the Alberta-Saskatchewan boundary. The Dark Brown and Very Dark Brown Belts would occupy the areas between the above two lines. These two belts would increase in width with their northern developments. Certain developments of darker colored soils occur within the Brown Belt due to certain topographical features, as previously referred to.

There exist as great differences in the chemical composition of the soils of western Canada as is found in their physical natures. The following table 7, aids in bringing out these differences in composition between the various type of soils, of the various plains and rainfall belts.

The data included in table 7 have largely been taken from our analyses of Alberta soils (9, 10), together with analyses of Manitoba and Saskatchewan soils by Shutt (8), and analyses of Saskatchewan soils by Hansen (4).

The data in the above table have been selected with the idea of representing the soils of the different plains and rainfall belts. The analyses by Dr. Shutt represents the acid soluble minerals, whereas those by Hansen and ourselves represent the totals. Thus Dr. Shutt's figures for potassium are lower than

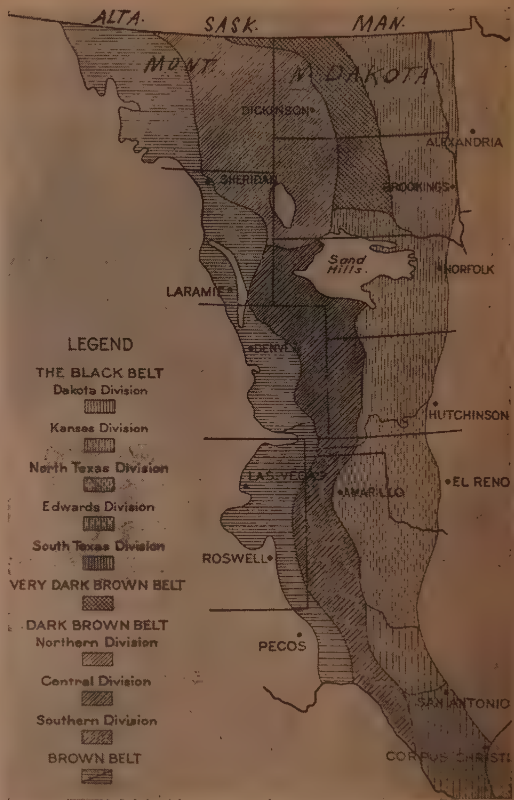


Fig. 6—Soil Belts of the Great Plains.
(*Courtesy Marbut*)

they would have been according to our method for determining total potassium. The figures from these three sources have all been computed to the same basis.

The table brings out a few striking facts. In general, these soils are extremely well supplied with nitrogen and likewise organic matter. In fact this is the most striking characteristic they possess. The lighter soils contain less nitrogen than do the intermediate or heavy soils. The lowest nitrogen content is only about one tenth as great as the highest. All soils from the dryer district contain less nitrogen than do similar soils from districts of heavier rainfall. However, under the climatic conditions of these plains most soils exhibit a rapid rate of decomposition of the organic matter as indicated by the production of nitrates and the consequent formation of available mineral plant foods. Unpublished data from the University of Alberta show that loams from the Edmonton district contain

TABLE [illegible] CHEMICAL COMPOSITION OF WESTERN CANADIAN SOILS

SOIL TYPE	LOCALITY	N	P	K	Ca.	Mg.	Carbonates in terms of $CaCO_3$
Light brown fine sand	Southern Alberta	.071	.031	1.151			.022
Light brown sandy loam	Southern Alberta	.131	.051	1.37	1.02	.43	1.29
Black sandy loam*	West central Alberta Innisfail	.326	.066	.312*	.485		
Black sandy loam*	East central Sask. Yorkton	.504	.092	.403*	.900		
Brown sandy loam †	South central Sask. Moose Jaw	.165	.055	1.47			slightly acid to slightly alkaline
Black sandy loam *	Manitoba Portage la Prairie	.651	.077	.546*	.75		
Brown loam	Southern Alberta	.179	.061	1.74	1.05	.50	.79
Black loam	Central Alberta, Edmonton	.700	.120	1.492			
Black loam	Northern Alberta	.381	.103	1.637			slightly acid
Black loam *	South eastern Saskatchewan, Wolsley	.514	.170	.460*	.620		
Dark brown loam †	South central Saskatchewan, Moose Jaw	.222	.046	1.568			neutral to slightly alkaline
Black loam *	South western Manitoba, Brandon	.346	.054	.679*	.815		
Brown silt loam	Southern Alberta	.188	.061	1.650	1.43	.58	2.08
Light brown silt loam	West central Alberta, timber (burnt over)	.105	.041	1.595			distinctly acid
Black silt loam	West central Alberta (prairie)	.592	.156	1.640			distinctly acid
Brown clay loam	Southern Alberta	.200	.059	1.840	1.39	.75	1.77
Black clay loam	Central Alberta	.695	.114	1.489			
Dark brown clay loam	Northern Alberta, Grande Prairie	.301	.081	1.856			slightly alkaline
Black clay loam *	South eastern Saskatchewan, Indian Head	.371	.102	.720*	1.007		
Brown clay loam *	South western Saskatchewan, Maple Creek	.134	.028	.249*	.757		
Dark brown clay loam †	South central Saskatchewan, Moose Jaw	.249	.049	1.722			slightly acid to slightly alkaline
Black clay loam *	Southern Manitoba, Morris	1.005	.126	.855*	1.35		

* Analyses by Shutt (Bull. 22, New Series, Department of Agriculture, Canada.

† Analyses by Hansen, Saskatchewan Soil Survey Report No. 1.

per acre at the end of the summer fallow year, sufficient nitrate nitrogen and water soluble phosphorus to more than supply the demands of a 50 bushel crop of wheat without the subsequent transformation of either of these two materials into available forms during the growing period of the wheat.

These soils in general are well supplied with the mineral plant foods. In no case are they deficient in potassium or calcium. In most cases they contain an abundance of limestone. However, in various areas they are slightly or even appreciably acid in reaction. The limestone zone usually occurs a bit further below the surface in the dark colored soils than in the light colored soils.

Generally they contain an abundant supply of phosphorus but in certain restricted districts there is a tendency toward a deficiency in this element

In general they contain a relatively large supply of available plant foods.

SUMMARY

The plains of Western Canada extend from the western escarpment of the Laurentian Plateau to the foothills of the Rocky Mountains, and vary in elevation from about 500 to 3500 feet. They may more properly be considered as a series of plains rising in elevation from east to west with average elevations of 800, 1600 and 3000 feet respectively. The surface appearance is most uniform for the east plain and least uniform for the west plain. There is to a certain extent a uniformity within the soils of the respective plains conforming to the uniformity in topography. This is to be expected when it is understood that the agencies which have weathered and distributed the soil materials are the agencies chiefly instrumental in producing the topography.

The soils of the eastern plain are more largely the result of lacustrine conditions than those of the other two plains which have been more largely affected by the influences of glaciation and erosion.

The factors which have left their imprint on the soils of western Canada are in general the same factors which have produced the present soil conditions in various parts of the world; but throughout the world different individual factors have exerted varying degrees of influence upon the soils of the respective regions. The different productivity of the soils of western Canada is due to the degree of influence exerted by one or several of the various factors which are responsible for the formation, distribution and modification of the soil mass.

These factors may be briefly grouped as follows: lithological, weathering and distribution agencies, climate. Each of the above groups may be further divided into several factors.

The shales and sandstones underlying these plains, consist largely of fine sand, very fine sand, and silt cemented together either with limestone or clay. These parent rocks have contributed largely to the formation of the present soils. Thus when the sandstones weather they produce soils of light texture, whereas when the shales weather they produce soils of heavy texture. The weathered materials from these rocks, when mixed with the glacial till have left, in general, a large proportion of medium textured soils.

The weathering and distribution factors have been chiefly ice, water and wind. They have been responsible for the wearing away of the country rocks, the carrying in of outside drift, the transportation, mixing and assorting of the local materials. It is due to these agencies that we find in some areas of the plains well sorted and uniform materials, whereas in other areas we find imperfectly mixed and thoroughly non-uniform soils. The most uniform soils are those laid down under lacustrine conditions, and the least uniform areas are the galcial drifts especially the morainal areas. In general the entire area has been subjected to glaciation, the only exceptions being in cases where the initial plains were above the various ice thrusts, examples of which may be mentioned, such as Sypress Hills, Hand Hills and Swan Hills. These hills have an elevation slightly greater than 4000 feet above sea level. They show no distinct evidence of glaciation, but glacial material surrounds these hills and extends well up on the slopes of the escarpments. The tops of these hills

consist of true residual soils resulting from the weathering of the conglomerate which caps them. Glacial drift coveres the surrounding plains to a depth of from a few inches to several hundred feet. The drift is found to be shallow on the pre-existing plateaus and deep in the pre-existing valleys.

The main drift covering these plains has been brought in by the Keewatin glaciers. This drift covers practically all of the prairie provinces, and extends well to the south of the boundary line. However, the soils of the extreme western part of Alberta are influenced by glaciers from the Rocky Mountains, and between the fronts of the Keewatin and Cordilleran glaciers the soils are materially different from the soils of the middle and eastern plains.

Water erosion has been greatest on the western plain and least on the eastern plain. The greater parts of the eastern and middle plains, and about one half of the western plain lie in the drainage basin of the Hudson Bay. A small part of the middle plain and about one half of the western plain drain into the Arctic Ocean, whereas a small area in the south western part of the western plain drains into the Gulf of Mexico.

The climatic factors have exerted more influence upon the present productive power of the various soil types in various districts than have the lithological or weathering agencies, in that the climate has been responsible for the nitrogen and organic matter content of the various soils.

The climate may be characterized by dry cold winters during which no growth occurs. The soil is practically sterile during this period. Winter is followed by the slow advancement of spring, and the subsequent rapid advancement of summer. The advancement of summer is accompanied by high daily temperatures, with long hours of sunshine and sufficient moisture to enable rapid preparation of plant food and astonishing crop growth.

The season between frosts varies from about 100 to 130 days for various years and various parts of these plains.

The total rainfall is on the whole rather light (from about 12 to 20 inches average) with rather wide variation from these averages. However, owing to the fact that about 75 per cent of it falls from April 1st to October 31st, during the growing season, it is more efficient in producing crops than would be the case provided a greater proportion occurred during the fall and winter seasons.

The climate favours rapid growth for a period of the year coinciding with the greatest rainfall, followed by dry cold weather which delays and often almost immediately prevents the decomposition of organic matter and the loss of plant foods until the following spring when the temperature and moisture again permit the rapid preparation of plant foods at a time when they are in greatest demand.

The above conditions have been responsible for the present vegetation covering these plains, and this native vegetation has been responsible for the nitrogen and organic matter content of the soils. From the standpoint of native vegetation these plains may be divided into three main regions. First, the prairie areas which are virtually devoid of trees and contain chiefly the short grasses. These areas coincide in general with the areas of low rainfall. Second, the park areas which are really the districts of mixed prairie and trees, such as bush and willows. These areas occur adjacent to the prairie districts. Third, the wooded areas, which in general occupy the districts of greatest rainfall.

A rainfall map would in the main have lines closely related to the native vegetation. A crop production map would likewise be closely related to these same areas. However, the rainfall and production areas would somewhat overlap the vegetation areas owing to the fact that districts of lightest rainfall have the longest growing season and the highest rate of evaporation. Again there are certain local features, such as topography and soil types, which influence the native vegetation and the efficiency of a unit of rainfall.

The rainfall increases in three directions, north, east and west from the centre of low-

est precipitation (south eastern Alberta and south western Saskatchewan). However, the eastern plain is under a heavier rainfall than either the middle or western plain.

The rainfall and soil belts of the Canadian prairies are continuations of similar conditions found on the Great Plains south of the boundary line. However, the following differences occur; the lowest rainfall of the Canadian Plains is higher than the lowest rainfall of the Great Plains, and the highest rainfall of the Canadian Plains is lower than the highest rainfall of the Great Plains.

The soils of the plains of western Canada differ widely in texture. However, a very large proportion of them are intermediate in texture. They likewise differ widely in chemical composition, but on the whole are extremely fertile. They are rather well supplied with nitrogen and organic matter, in fact that is their most striking characteristic. They are, in general, well supplied with mineral plant foods, (for detailed comparisons see Table 7 and following discussion).

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RAILWAY RATES TO ROYAL WINTER FAIR

For the information of patrons and prospective patrons of the Royal Winter Fair which opens November 13th in the Royal Coliseum, Toronto, and continues for eight days, special reduced railway fares on all railways will be effective as follows:

General Public—From all stations in Ontario and Quebec, between Grant, Jellicoe or White River and Quebec City, current one-way ordinary first-class fare and one-third for the round trip will be in effect, good going to Toronto, November 12th to 21st, inclusive, and returning not later than November 23rd, 1925. From all stations east of Quebec City, Levis and Megantic including the Maritime Provinces, the rate will be current one-way ordinary first class fare and one-third for the round trip, good going to Toronto from November 10th to 19th, inclusive, and returning not later than November 23rd.

Judges and Exhibitors — Rates apply from all stations in Canada east of Port Arthur and Armstrong, including the Maritime Provinces. On surrender of standard form of Judges' and Exhibitors' Certificates signed by Mr. A. P. Westervelt, Manager, tickets will be sold to Toronto at current ordinary one-way first class fare and one-third for the round trip, good going to Toronto from October 29th to November 12th, inclusive, and returning not later than November 25th, 1925.

Some Statistical Observations on a Yield Test of Potato Varieties.

L. E. KIRK and C. H. GOULDEN

It is a matter of common knowledge that the yield of potatoes varies greatly with soil differences. Whether this crop shows a greater response than other crops to the heterogeneity of normal soils does not appear to have been studied. Indications are not wanting however that this may be the case.

For a number of years extensive variety tests with potatoes have been carried on at this institution*. At first they were made with single eight rod rows and check plots. It was soon obvious that replication should be practised and all varieties were accordingly replicated once. Then two replications were adopted making three series of each variety. To save space, check plots were omitted and the probable error calculated by "deviation of the mean method". The first year that the latter plan was used, soil differences introduced a systematic error so that the probable error was considerably less for two than for three series of plots, and this on a field that we had previously considered quite uniform for cereal crops. A somewhat heavier type of soil made a very great difference in the productiveness of the varieties on the third series.

In 1924 it was decided to try a variety test by planting the tubers in rod rows replicated a large number of times and with check plots every fifth row. Although the field chosen for this work, from surface appearances, was as uniform as anything which we have, and although the other conditions of the experiment were favourable for a minmum coefficient of variability, the variation in yield between rows of the same variety was strikingly large. Nevertheless with so many check plots and replications a very reliable probable error was secured. Although the latter was large, the results of the test were considered much more reliable than any previously obtained. Incidentally an opportunity was afforded for making some observations from a statistical study of the data.

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Methods and Conditions of Experimentation

Twenty distinct varieties of potatoes were used in this test. There were fifteen systematically distributed single rod rows of each variety and throughout the entire group every fifth row was an Early Ohio check. This made a total of 375 plots, 75 of which were check plots. Outside rows were planted as guards. Reference to Table II will make clear the exact manner of plot arrangement in the field.

It may be well to state also that 17 of the 20 varieties were the product of superior single tuber selections and hence pure as to breeding. This fact is mentioned because it eliminates what might easily be a source of variability in yield. Those varieties that were not from tuber selections had been under test for eight years and were known to be true to type.

The rod rows were planted in series across the field, the rows spaced five links apart (nearly 3½ feet), and with 3½ foot passes between the series. All planting and harvesting was done by hand. The sets were carefully cut to about two ounces and planted singly 20″ apart in the row. The stand of plants was perfect there being no misses either from failure to sprout or from disease. The nearly complete absence of disease in this particular test is worthy of mention, as its presence so frequently introduces errors so large as to make comparisons for yield impossible. The variability in yield which is some times introduced by disease alone is one of the most difficult problems that has to be considered in variety testing of potatoes.

It will be observed that the yields if figured on an acre basis are rather small. This may be attributed to the exceptionally dry season. There is no doubt that moisture was a limiting factor under conditions of this ex-

TABLE I.

Individual plot yields of potato varieties in pounds per plot

The actual location of plots in the field is indicated in Table II.

Number of Replicates.

Variety		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Average
Check		16.0	6.0	11.0	12.0	8.0	9.0	9.0	10.0	7.0	7.0	8.0	5.0	10.0	15.0	15.0	9.87
Irish Cobbler	1	14.5	6.9	11.3	10.3	7.4	9.4	11.3	7.9	7.0	4.5	7.1	7.5	5.8	12.0	13.0	9.06
Gold Nugget	2	14.0	5.2	7.8	10.9	7.7	8.1	8.4	7.5	6.0	11.9	5.8	6.9	6.7	9.9	12.2	8.60
Ricketts Cobbler	3	13.7	8.8	8.7	8.0	6.1	8.5	10.3	9.0	8.1	9.5	7.5	8.3	13.4	10.9	9.5	9.35
Early Ohio	4	11.7	6.4	9.0	10.2	5.9	11.3	8.8	6.3	6.7	8.8	6.6	6.9	13.1	8.6	10.4	8.71
Check		16.0	7.0	12.0	12.0	6.0	10.0	11.0	8.0	6.0	9.0	7.0	7.0	12.0	10.0	12.0	9.67
Early Six Weeks	5	17.5	7.0	10.2	11.2	3.0	7.2	8.1	13.2	5.5	8.5	6.6	8.3	10.6	7.1	13.0	9.13
Rochester Rose	6	11.9	5.2	9.5	11.9	6.6	9.1	8.5	6.8	2.5	5.1	5.6	6.3	9.1	13.2	14.3	8.37
Early Triumph	7	12.9	5.7	7.6	8.0	5.1	10.0	9.0	8.1	5.6	7.3	5.0	5.5	7.1	12.5	10.0	7.96
New Queen	8	14.3	6.2	7.9	8.7	6.2	7.1	9.0	7.9	7.2	6.0	4.9	4.9	10.9	10.1	10.9	8.15
Check		15.0	7.8	8.0	12.0	9.0	8.0	9.0	9.0	8.0	6.0	7.0	9.0	9.0	14.0	12.0	9.52
Beauty of Hebron	9	11.8	6.0	7.3	10.0	10.3	10.0	10.3	10.3	7.5	5.8	6.8	5.2	11.8	12.3	11.7	9.14
Bovee	10	12.6	11.9	7.1	10.9	10.2	8.1	10.7	9.0	9.1	6.5	7.7	7.5	10.7	12.7	8.8	9.57
Russet	11	9.0	12.7	9.2	9.4	9.4	6.9	10.7	6.2	6.0	3.0	5.1	5.6	11.4	9.3	5.1	7.93
Carman No. 1	12	11.3	17.9	8.4	11.0	12.4	9.4	11.3	10.6	7.7	5.2	10.0	10.0	9.4	12.0	10.4	10.47
Check		11.1	8.0	10.0	7.8	13.0	8.9	11.0	7.8	7.0	7.0	13.0	7.0	12.0	12.0	10.0	9.71
Gold Coin	13	12.8	15.8	8.1	9.5	10.8	8.2	8.5	9.6	7.5	6.7	10.2	9.4	11.8	12.2	10.4	10.10
Wee McGregor	14	10.1	13.3	8.5	8.5	9.0	8.2	8.7	7.7	8.3	4.7	12.3	7.5	11.3	13.1	8.9	9.34
Pingree	15	13.1	16.1	8.6	8.9	10.4	7.3	10.1	8.8	6.7	5.5	11.9	9.1	9.7	13.2	9.3	9.91
Rural New York	16	8.2	10.0	7.8	5.4	9.8	4.9	6.2	8.0	6.0	3.8	8.1	8.7	9.9	10.5	9.0	7.75
Check		11.1	14.0	10.0	7.0	11.0	5.0	10.0	9.0	7.0	5.0	8.0	9.0	12.0	14.6	11.0	9.58
Early Peachblow	17	7.3	10.4	8.4	5.3	9.4	6.4	6.6	6.8	9.0	5.1	6.8	8.9	12.7	8.7	11.4	8.21
Everet	18	7.3	12.2	9.3	8.4	8.3	6.9	8.4	7.5	8.3	6.5	6.4	7.6	13.2	12.4	10.3	8.87
Early Carman	19	4.1	13.0	9.0	8.9	9.9	7.1	10.4	7.2	7.0	6.7	6.3	9.0	11.0	14.9	9.7	8.95
Magpot	20	6.0	11.5	9.7	10.0	7.4	6.5	7.8	5.5	4.5	5.7	6.2	8.0	9.0	15.6	11.0	8.29
Average for replicates		14.7	12.3	11.2	11.8	10.6	10.1	11.6	10.4	8.6	8.0	9.5	9.4	13.2	14.8	13.5	

TABLE II.

Individual Plot yields of potato varieties in pounds per plot. The arrangement of figures in the table indicates the actual location of plots in the field. A heavy line marks the end of each replicate.

NUMBER OF FIELD SERIES

1	2	3	4	5	6	7	8	9	10
16.0	12.7	10.3	12.4	8.4	7.8	9.5	10.2	13.1	13.1
14.5	17.9	10.9	13.0	10.3	9.6	8.8	12.3	12.0	13.2
14.0	8.0	8.0	10.8	8.8	7.7	9.0	11.9	10.6	10.5
13.7	15.8	10.2	9.0	11.0	8.8	8.5	8.1	9.1	14.6
11.7	13.3	12.0	10.4	8.1	8.0	5.1	8.0	7.1	8.7
16.0	16.1	11.2	9.8	8.5	9.0	7.3	6.8	10.9	12.4
17.5	10.0	11.9	11.0	9.0	6.8	6.0	6.4	9.0	14.9
11.9	14.0	8.0	9.4	9.0	7.5	6.0	6.3	11.8	15.6
12.9	10.4	8.7	8.3	9.0	7.2	5.8	6.2	10.7	15.0
14.3	12.2	12.0	9.9	10.3	5.5	6.5	5.0	11.4	13.0
15.0	13.0	10.0	7.4	10.7	7.0	3.0	7.5	9.4	12.2
11.8	11.5	10.9	9.0	10.7	7.0	5.2	6.9	12.0	9.5
12.6	11.0	9.4	9.4	11.3	6.0	7.0	8.3	11.8	10.4
9.0	11.3	11.0	8.1	11.0	8.1	6.7	6.9	11.3	12.0
11.3	7.8	7.8	8.5	8.5	6.7	4.7	7.0	9.7	13.0
11.1	8.7	9.5	11.3	8.7	6.0	5.5	8.3	9.9	14.3
12.8	9.0	8.5	10.0	10.1	5.5	3.8	6.3	12.0	10.0
10.1	12.0	8.9	7.2	6.2	2.5	5.0	5.5	12.7	10.9
13.1	10.2	5.4	9.1	10.0	5.6	5.1	4.9	13.2	12.0
8.2	9.5	7.0	10.0	6.6	7.2	6.5	9.0	11.0	11.7
11.1	7.6	5.3	7.1	8.4	8.0	6.7	5.2	9.0	8.8
7.3	7.9	8.4	8.0	10.4	7.5	5.7	7.5	15.0	5.1
7.3	8.0	8.9	10.0	7.8	9.1	8.0	5.6	12.0	10.4
4.1	7.3	10.0	8.1	10.0	6.0	7.1	10.0	9.9	10.0
6.0	7.1	8.0	6.9	7.9	7.7	5.8	7.0	10.9	10.4
6.0	9.2	7.4	9.4	7.5	7.0	7.5	9.4	8.6	8.9
6.9	8.4	7.7	8.9	9.0	7.5	6.6	7.5	10.0	9.3
5.2	10.0	6.1	8.2	6.3	8.3	7.0	9.1	7.1	9.0
8.8	8.1	5.9	8.2	8.0	6.7	6.6	8.7	13.2	11.0
6.4	8.5	6.0	7.3	13.2	6.0	5.6	9.0	12.5	11.4
7.0	8.6	3.0	4.9	6.8	7.0	5.0	8.9	10.1	10.3
7.0	7.8	6.6	5.0	8.1	9.0	4.9	7.6	14.0	9.7
5.2	10.0	5.1	6.4	7.9	8.3	7.0	9.0	12.3	11.0
5.7	8.4	6.2	6.9	9.0	7.0	6.8	8.0	12.7	
6.2	9.3	9.0	7.1	10.3	4.5	7.7	10.0	9.3	
7.8	9.0	10.3	6.5	9.0	7.0	5.1	5.8	12.0	
6.0	9.7	10.2	9.0	6.2	4.5	10.0	6.7	12.0	
11.9	12.0	9.4	11.3	10.6	11.9	13.0	13.4	12.2	

periment and that under more favorable conditions much larger differences in yield as between varieties would have been evident. The yields given are for marketable tubers only, the product of each row being put through a grading machine before weighing. Because the tubers as a whole were somewhat undersized, and keeping in mind the requirements of this study, the grader was adjusted so that only the very small tubers were removed.

Table I gives the individual plot yields and average yield of each potato variety in pounds per plot. The average yield for each replication including the checks is also given at the bottom of each column. Table II is presented for the purpose of showing the actual location of each plot in the field and the method of replication, the end of each replication being marked by a heavy line. While the distribution of plots is fairly good, it is not perfect in that the plots of every third replicate are almost end to end. This would help to account for the slight differences in averages between the five series of 15 checks. (See Table I).

A perusal of the columns of figures in Tables I and II clearly discloses a systematic error in the field due to soil conditions. In Table I the yields are progressively poorer from the first to the tenth replicate, after which they quickly improve to the fourteenth. In Table II the yields decrease to the sixth series and then begin to improve. Averages for the replicates and field series brings this out still more clearly. In addition, Table II shows a very marked decrease in yield for the first four series from top to bottom. The systematic error here is even more marked than in the other direction. A comparison of the first ten varieties of the first replicate with the same varieties of the second replicate, both of which are included in the first series of plots shows the yields of the latter to be less than one half those of the former, all of which serves to illustrate in a striking manner the need for adequate replication.

That replication is effective, under these conditions, is evident because the averages of each series of 15 checks are practically the same.

Methods of Determining the Probable Error

A probable error of this experiment was obtained by the "Check Plot" method and also by the "Deviation of the Mean" method. The large number of variety plots and checks involved makes the data especially suitable for comparing these methods of determining a probable error of the experiment.

The Check Plot Method is widely used and, when a sufficient number of checks are available to provide a true random sample, gives a probable error which may be considered a reliable index of the soil heterogeneity. In the absence of a sufficient number of properly placed checks other methods have been devised for securing a probable error by making use of replicated variety yields. It is evident that such methods are more liable to represent the average variability of the varieties tested than a single variety arbitrarily selected for use as a check.

The Deviation of the Mean method is a modification of Wood and Stratton's pairing method and was devised by Dr. H. K. Hayes, Professor of Plant Breeding, University of Minnesota, and very briefly described in Hayes and Garber's "Breeding Crop Plants" (1). It has been used by the plant breeding section at University Farm, St. Paul, for a number of years and also at a number of other places, with such success that its merits and use deserve to be more widely understood and appreciated. An example, using the first and second replicates, will serve to illustrate how the method is applied. When there are more than two plots of each variety, a deviation from the mean in percent is secured for each and the summation of $(\text{Dev.}\ \%)^2$ is divided by the total number of deviations before extracting the square root.

TABLE III.

Probable Error calculated by Deviation of the Mean method using the results of the first and second replicates only, including checks.

Variety Number		Mean	Dev. %	(Dev. %)²
Ck.	16.0			
	6.0	11.0	45.5	2070.25
1	14.5			
	6.9	10.7	35.5	1260.25
2	14.0			
	5.2	9.6	45.8	2097.64
3	13.7			
	8.8	11.3	26.4	696.96
4	11.7			
	6.4	9.1	28.6	817.96
Ck.	16.0			
	7.0	11.5	39.1	1528.81
5	17.5			
	7.0	12.3	42.3	1789.29
6	11.9			
	5.2	8.6	38.4	1474.56
7	12.9			
	5.7	9.3	38.7	1497.69
8	14.3			
	6.2	10.3	38.8	1505.44
Ck.	15.0			
	7.8	11.4	31.6	998.56
9	11.8			
	6.0	8.9	32.6	1062.76
10	12.6			
	11.9	12.3	2.4	5.76
11	9.0			
	12.7	10.9	16.5	272.25
12	11.3			
	17.9	14.6	22.6	510.76
Ck.	11.1			
	8.0	9.6	15.6	243.36
13	12.8			
	15.8	14.3	10.5	110.25
14	10.1			
	13.3	11.7	13.7	187.69
15	13.1			
	16.1	14.6	10.3	106.09
16	8.2			
	10.0	9.1	9.9	98.01
Ck.	11.1			
	14.0	12.6	11.1	123.21
17	7.3			
	10.4	8.9	16.9	285.61
18	7.3			
	12.2	9.8	24.5	600.25
19	4.1			
	13.0	8.6	51.2	2621.44
20	6.0			
	11.5	8.8	30.7	942.49

$$\Sigma(\text{Dev. }\%)^2 = 22907.34$$

$$\sigma = \sqrt{\frac{22907.34}{25}} = 30.27034$$

$$\text{P.E. }\% = 30.27034 \times .6745 = 20.417$$

As a matter of interest the P.E. by the deviation of the mean method was determined also when only three and five of the replications were used. The following results were obtained:

No. of Replications	P.E.	Dev. from P.E. calculated from 14 replications
1.	20.42	+1.19
3.	17.62	–1.61
5.	18.60	–0.63
14.	19.23	0.00

This shows that reducing the number of replications does not influence the P.E. significantly. This is especially important when it is noted that the number of check plots in the first replication only is much too small from which to calculate a reliable P.E.

For this experiment the following probable error values were secured by the two methods under discussion.

Check plot method 18.96%
Deviation of the mean method..19.23%

This is the probable error in percent of a single determination. The values are in very close agreement which of course is to be expected if the deviation of the mean method is mathematically sound and the following conditions are fulfilled: (1) when sufficient check plots are used to provide a true random sample of the soil: (2) when a sufficient number of systematically distributed plots are used of the varieties which are

being tested to provide a true random sample of the soil; and (3) when the variety used in the checks is not more or less variable than the average variability of all of the varieties in the test.

All three conditions are fulfilled in the potato variety test under discussion. The first and second are adequately met by the use of 75 check plots and 15 replicates each of 20 varieties. That the third condition is also met can be shown by comparing the average coefficient of variability for all of the varieties with the coefficient of variability determined from the check plots. These are listed in Table IV.

TABLE IV.

Coefficients of Variability of Potato Varieties

$Check_1$	22.31
Irish Cobbler	20.72
Gold Nugget	19.80
Rickett's Cobbler	11.12
Early Ohio	16.83
$Check_2$	1935
Early Six Weeks	25.65
Rochester Rose	26.19
Early Triumph	20.69
New Queen	20.28
$Check_3$	17.58
Beauty of Hebron	17.49
Bovee	11.62
Royal Russet	22.49
Carman No. 1	17.08
$Check_4$	14.88
Gold Coin	15.16
Wee McGregor	16.16
Pingree	18.02
Rural New Yorker	17.26
$Check_5$	19.56
Early Peachblow	17.32
Everett	16.10
Early Carman	19.99
Magpot	22.94
Mean —	18.66
Coefficient of Variability by Check Plots —	18.96

The deviation of the mean method of securing a probable error is of great value where space does not permit the use of check plots. It is more reliable also to calculate the probable error of this method from replicated variety plots than by the check plot method when the number of checks are small and probably when the variety used in the checks does not exhibit average variability.

The Value of Replication as Measured by Reduction in Variability

It is an interesting question to what extent variability in yield has been reduced by replication under conditions of this experiment. If all plots had been planted with the same variety, the rate and extent of reduction in variability could have been easily determined by calculating the probable errors for increasing numbers of replicates. This treatment in the present instance is inadmissible because a variable factor other than that of soil heterogeneity is introduced due to the inherent differences of varieties in yielding ability. Nor is it possible to get away from this difficulty by placing the yields on a percentage basis as by assuming that the average yield of each variety is 100, the probable error when all replications are considered is mechanically reduced to zero.

An attempt has been made however to demonstrate the value of replication by combining the plots in different ways so as to give 1, 2, 3, 5 and 7 sysematically distributed plots of each variety, calculating the proabble error in percent by the deviation of the mean method, and comparing the values obtained with the theoretical according to the formula — (P.E. of single determination $\div\sqrt{n}$). Deviations from the mean of all 15 replicates of each variety are used to get the probable error of a single determination. Then 14 replicates of each variety are combined in seven pairs and deviations from the mean of these seven used to get a probable error of the average of one pair, or two systematically distributed plots. Thus also the 15 replicates may be combined in groups of three, five and seven. Table V gives the actual and theoretical results of such a calculation.

TABLE V

Actual and theoretical probable errors in percent for 1, and the means of 2, 3, 5, 7 systematically distributed plots.

No. of Plots	P.E. in %	Theoretical P.E. in %
1	19.23	19.23
2	13.79	13.60
3	12.29	11.10
5	8.98	8.60
7	5.10	7.27

The results are very close to mathematical xpectation and fully justify the amount of eplication employed for the size of plot used. 'arietal differences are not here a source of rror and nearly all plots are included in ach calculation.

Comparison of Varieties. Probable Error of a Difference.

Having obtained a probable error of the xperiment, i.e. of a single determination, he probable error for any particular variety s calculated by dividing the former by the quare root of the number of systematically listributed plots of the variety. Thus if here were four plots of each variety and the '.E. is 20 per cent. the P.E. of the mean yield vould be $20 \div \sqrt{4} = 10\%$. The justification or this calculation is based on the law of hance. When all varieties in a comparative est are replicated the same number of times, he P.E. for each of them will be the same.

A comparison of any two varieties makes t necessary to take into account the "Prob-ble Error of a Difference. For just as the nean yield of each variety is a variable uantity, so also is the difference in the yield etween two varieties subject to a correspond-ng variability.

The probable error of a difference pro-ides a very useful index of the significance f the difference in yield. If one variety of heat yields 20 bushels per acre and another 2 bushels, the difference of two bushels may r may not be a significant difference. With P.E. of two bushels the chances are even at one variety is better than the other. It ay also be said that there is an even chance at it is not a better yielder. If however e P.E. were one bushel, or only half the ifference, the odds (4) become 4.64:1 in avor of the variety with the greater yield. Vith a difference of three times the P.E. the dds become 22.26:1 that the difference in ield is significant. There remains always e possibility that the difference is due to hance rather than inherent yielding ability, ut the larger the ratio between difference nd P.E. the greater the odds that the spread yield between the two varieties represents real difference. It is generally agreed at a difference of at least three times the .E. is required before it should be consid-ered significant.

The probable error of a difference has been made use of by Hayes (1) in plot yield tests for the purpose of making more accurate elimination of the lesser yielding sorts. Each variety or strain is replicated the same number of times and the P.E. calculated. Three times the P.E. is then subtracted from the highest or one of the highest yielding varieties. This gives an elimination value below which yield, varieties may be discontinued with reasonable assurance that nothing valuable, so far as yield is concerned, is being discarded. Varieties or strains which fall below the elimination value for three years in succession are not carried in the test any longer.

An expression for the standard deviation of a difference has been given by Pearl (3, 5), as follows:

$$\sigma_{x-y} = \sqrt{\sigma_x^2 + \sigma_y^2 - 2r_{xy}\,\sigma_x\,\sigma_y} \quad \text{.................(1)}$$

where x and y denote any statistical constants, and x-y, the difference between them. σ denotes the standard deviation of the variable indicated by its subscript and r_{xy} is the coefficient of correlation between x and y. This relationship between the standard deviation of a difference and the two variables may also be expressed in terms of the probable errors:

$$E_{x-y} = \sqrt{E^2_x + E^2_y - 2r_{xy}\,E_x\,E_y} \quad \text{..................(2)}$$

where E represents the probable error of the variable attached as a subscript.

It is evident from (2) that the correlation coefficient must be taken into consideration in determining the probable error of a difference. As pointed out previously by "Student" (7), Kemp (2), and Richey (6) a positive correlation is known to exist between the yields of variety plots depending on the relative positions of the plots in the field. The effect of different values of r_{xy} on E_{x-y} between plot yields may be shown in a concrete manner by assuming that $E_x = E_y$. Equation (2) then becomes—

$$E_{x-y} = E_x\sqrt{2\ (1-r_{xy})} \quad \text{........................(3)}$$

and when $E_x = E_y = 1$,

$$E_{x-y} = \sqrt{2(1-r_{xy}} \quad \text{..................................(4)}$$

Substituting different values of r_{xy} in (4), the following values of E_{x-y} are obtained.

The third column shows the percent reduction in $E_{x\cdot y}$ due to different values of r_{xy}.

r_{xy}	$E_{x\cdot y}$	Percent reduction in $E_{x\cdot y}$ due to r_{xy}
.0	1.414	0.00
.1	1.341	5.09
.2	1.264	10.54
.3	1.184	16.34
.4	1.100	22.56
.5	1.000	29.28
.6	.894	36.78
.7	.775	45.19
.8	.617	55.30
.9	.447	68.39
1.0	.000	100.00

When r_{xy} is small, $2r_{xy}\ E_x\ E_y$ is also small, especially in relation to E^2_x and E^2_y. The influence of r_{xy} in such cases is therefore negligible as determined by its effect on the probable significance (4) of $E_{x\cdot y}$. In variety tests in which very accurate comparisons are to be made it would seem desirable to take into consideration correlation coefficients of .4 or more, but in ordinary work where differences must be large in order to be of real significance, coefficients of .5 or less may be neglected. In all cases it is at least necessary to know the degree of correlation between adjacent plots as it may be large enough to make a significant difference between two varieties otherwise impossible.

In this study the following correlation coefficients were secured for plot yields at different distances apart.

One apart (Adjacent Plots)	$r_{xy} = .6707 \pm .0194$
Three apart	$r_{xy} = .5967 \pm .0234$
Six apart	$r_{xy} = .5042 \pm .0283$
Ten apart	$r_{xy} = .4864 \pm .0305$

The degree of correlation was not reduced below about .5 when the yields of plots further than 10 apart were considered. The study, was of course restricted by the number of plots in a series.

Table VI is a correlation surface for yields of plots one apart throughout the experiment.

SUMMARY

1. Twenty distinct varieties of potatoe were tested each in 15 systematically distri buted rod rows.

2. Mere inspection of the tabulated yield of individuals showed the soil to be highl variable and therefore that extensive replica tion was necessary in order to obtain reliabl results.

3. The probable error of the experimen determined by the check plot and by th deviation of the mean methods was ver high and for practical purposes the same i both cases.

4. Evidence was brought forward to sho that the deviation of the mean method give a reliable probable error and is of specia value when the number of checks is small.

5. The value of replication was studie by determining probable errors by the devia tion of the mean method for 1 and the mean of 2, 3, 5 and 7 systematically distribute plots. The reduction in variability was ver close to mathematical expectation and in dicated that at least 7 systematically distri buted rod row plots was necessary in orde to obtain a reliable test.

6. The relation of the correlation betwee plot yields and the probable error of a dif ference is discussed briefly. The correlatio between nearby plots was found to be su ficiently high to indicate the necessity of i being taken into consideration. Ordinaril small correlations may be neglected.

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TABLE VI

Correlation surface for yields of adjacent plots.
X=Yields of Plots

Y=Yields of Adjacent Plots

	2.5	4.0	5.5	7.0	8.5	10.0	11.5	13.0	14.5	16.0	17.5	Totals
17.5									2			2
16.0								1	2			3
14.5				2		1	2	4	3	1	1	14
13.0		1		2		2	6	3	4		1	19
11.5			1		10	16	10	6	4	1		48
10.0				7	20	21	16	2	1			67
8.5			6	22	26	19	4	3				80
7.0	2	4	12	36	21	9	3	1		1		89
5.5		2	7	17	6							32
4.0		2	4	3								9
2.5			2									2
Totals	2	9	32	89	83	68	41	20	16	3	2	365

$\sigma_y = 1.7318$ $\sigma_x = 1.7439$ $r_{xy} = .6707 \pm .0194$

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La Revue Agronomique Canadienne

RÉDACTEUR—H. M. NAGANT

Le problême de la circulation de la sève.

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Est-il possible qu'il y ait encore des problèmes à résoudre sur la circulation de la sève? Assurément, oui; et, pour s'en persuader, il suffit de sortir des manuels élémentaires de Botanique où, trop souvent, d'impeccables schémas nous disent ce que la plante devrait être, non ce qu'elle est; comment elle pourrait exercer ses fonctions; comment le plus simplement du monde la sève devrait se conduire dans son long voyage à pic vers les feuilles, et non en fait comment la plante fonctionne, comment telle plante, en particulier notre érable à sucre, pousse le long de ses racines et de sa tige, son eau sucrée qui signifie pour nous des choses aussi importantes que la "trempette", le sirop et le sucre du pays.

Le problème de la circulation, posé scientifiquement, est sérieux, voire gros de difficultés, en tout cas controversé. Brièvement, cet article exposera l'état de la question.

La circulation de la sève se fait apparemment, grâce à une poussée de la sève de bas en haut, due à la racine et à une aspiration, une succion de haut en bas due à la feuille. Oui! une sorte de pompe aspirante et refoulante tout à la fois. Cette explication simpliste de la circulation est si naturelle que, volontiers, on la croirait vraie à priori. Cette double action semble, en effet, nécessaire. N'a-t-on pas démontré que la pression exercée par les poils absorbants, peut chasser la sève jusqu'à une hauteur de dix mètres? Mais les grands Wellingtoniers de Californie mesurent jusqu'à 110 mètres; quelle force fait parcourir à la sève les 100 mètres de différence?

Il est juste de dire que la pression osmotique des racines varie avec les saisons et les espèces d'arbres considérées. Au printemps, le Bouleau soulève bien une colonne de mercure de 139 cm., mais le Mûrier lui, ne soulève qu'une colonne de mercure de 1 cm., et souvent il ne soulève rien du tout; le pouvoir osmotique est alors franchement négatif. Pourtant, à ce moment même la circulation se fait très bien chez le Mûrier. Il faut donc, en plus, une pompe aspirante; la feuille était tout indiquée pour tenir ce rôle. Très bien, mais....les arbres "aux feuilles éternelles" sont rares. Qu'est-ce donc qui fait *pleurer*, au printemps, les branches de nos érables encore privées de leurs feuilles? Qui osera dire que la sève ne perle pas au delà de 30 pieds? Qui osera dire encore qu'une bouture de peuplier, n'ayant ni feuilles ni racines, ne peut faire parvenir à ses bourgeons le liquide nourricier, du milieu où on l'a plantée?

L'absorption de la racine et la transpiration de la feuille constituent une pompe aspirante-refoulante insuffisante, manquant de synchronisme dans son fonctionnement, parfois même absente; et pourtant, la circulation ne cesse pas. Il faut donc autre chose. On a fait intervenir la cohésion et la capillarité.

1.—La cohésion fut mise en évidence par l'expérience que voici. Un long tube de verre est terminé à sa partie supérieure en entonnoir dans lequel on coule du plâtre fin qui est ensuite desséché. Le tube est rempli d'eau et renversé sur le mercure. Le plâtre absorbe l'eau qui s'évapore à sa surface et détermine l'ascension du liquide. Le mer-

cure est soulevé, dans certains cas, de plus de 5 mètres. Une traction de 7 atmosphères est alors insuffisante à provoquer la rupture de cette colonne de mercure.

Critique

1.—"Mais on ne tient pas compte des frottements", disent les adversaires.

Ce reproche est grave; les parois internes des vaisseaux n'ont pas le glissant du verre, c'est incontestable.

2.—"Il y a des bulles d'air dans les vaisseaux, disent les uns. Elles s'introduisent par la racine lorsque l'absorption est moins rapide que la transpiration."

—"Dans les vaisseaux il n'y a pas habituellement de bulles d'air prétendent les autres; leur présence amènerait la mort de la plante."

—"Il y a des bulles affirment enfin tranquillement d'autres auteurs," mais leur présence ne nuit nullement à la circulation, elle la favorise plutôt."

Qui faut-il croire?

2.—La capillarité. Supposons des vaisseaux de 8 microns de diamètre; on sait que dans un tube capillaire de ce calibre, l'eau monte à plus de 3 mètres au dessus de la surface du liquide, par l'intervention de la tension superficielle.

Critique

"Mais cette expérience n'est pas applicable, assurent de graves savants, s'il existe des bulles d'air."

Allons donc! Voilà encore les bulles d'air. Avant d'aller plus loin, demandons-nous si réellement elles existent; si oui, quel rôle elles ont sur la circulation.

1.—Y a-t-il réellement des bulles? ....

Il est bien probable qu'au printemps les vaisseaux ne contiennent que du liquide, l'absorption étant maxima, la transpiration faible, la vaporisation chlorophyllienne nulle. Mais plus tard, lorsque la photosynthèse et la transpiration sont à leur maximum, lorsqu'en raison inverse, la pression osmotique des racines a diminué au point de devenir négative, nécessairement un vide se produira et l'air happé entrera dans les vaisseaux.

2.—Que les bulles d'air, par leur nombre, soient capables d'assoiffer les parenchymes des feuilles et de la racine, et d'amener par suite la mort de la plante, personne n'en doute. Mais peut-on comparer les bulles d'air à des bouchons qui obstruent les vaisseaux à la façon des thylles et qui tuent le végétal, n'y eut-il qu'une bulle par vaisseau, c'est là le point controversé.

Jamin affirme en résumé qu'une pression infime peut déterminer un courant dans un tube capillaire en verre. Il faut une pression notable pour qu'il y ait circulation, si on introduit une bulle d'air; et plusieurs atmosphères, si on introduit un chapelet de bulles d'air. Et la résistance est encore plus grande si la cavité du tube, au lieu de cylindrique, est irrégulière comme l'est celle des vaisseaux.

Costantin et, peut-être avant lui, Van Tieghem considèrent les bulles d'air comme formées de deux ménisques inverses dont la tension superficielle correspond à des forces égales et contraires. Et pour cela, disent-ils, il est impossible de faire entrer les forces capillaires en jeu dans la circulation.

Schribaux et Nanot (Botanique agricole, p. 178-1922) soutiennent juste le contraire: "Les chapelets de bulles d'air, affirment-ils, ne font que réduire la section des vaisseaux, ce qui augments encore l'énergie de la capillarité"

Une expérience de M.J. Vesque prouverait cette assertion. Dans un tube thermométrique elliptique, aspirer un liquide rouge avec bulles d'air; fermer l'ouverture supérieure avec du plâtre qui boit l'eau, comme le ferait une feuille. Résultat: deux filets rouges montent le long des parois sans que les bulles d'air ne se déplacent. Sans bulles d'air, le vaisseau a un diamètre de 8 microns; si nous supposons une bulle d'air de 6 microns, sa présence réduira la section du tube à 2 microns et l'énergie de la capillarité sera augmentée d'autant.

Je laisse aux gens de physique le soin de critiquer ces deux dernières affirmations diamétralement opposées, ce semble, et les conclusions qu'on en tire.

Si la cavité des vaisseaux est bouchée par des bulles d'air, a-t-on pensé, pourquoi ne pas faire circuler la sève par les membranes? Hypothèse étrange, presque désespérée qui n'eut pas de vogue. Il a suffi de faire absorber aux vaisseaux du beurre de cacao ou de la paraffine pour enrayer toute circulation.

Une autre expérience d'Elfving est aussi très probante.

Deux cylindres de bois sont taillés dans une tige de Pin. On sait que le pachyte (bois 2aire) du Pin ne contient que des vaisseaux imparfaits, composés de cellules ponctuées exclusivement sur les parois latérales. Un 1er cylindre, taillé suivant le rayon de la tige, ne contient, sur la tranche, que des parois non aréolées. Un 2e cylindre, entaillé parallèlement à l'axe de la tige, coupe les vaisseaux-fibres en longueur et a sur sa tranche le maximum d'ouvertures vers l'intérieur des vaisseaux. Une goutte d'eau, appliquée sur la tranche de chacun de ces cylindres, demeure à la surface du 1er cylindre: aucune imbibition n'est observée; au contraire, l'eau à la surface du 2e cylindre est sur le champ absorbée.

"Donc, disent les uns, pas de circulation par la membrane des vaisseaux."

"Donc, disent les autres, pas de circulation par la cavité des vaisseaux."

Par où donc passe la sève alors?

Admettons:

1.—Que la sève ne circule pas entre les membranes des vaisseaux

2.—Qu'elle soit arrêtée par les bulles d'air,

Nous savons par ailleurs:

1.—Que la paroi du vaisseau est perméable partout où elle ne s'est pas lignifiée.

2.—Qu'entre les vaisseaux de l'aubier, il y a un tissu vivant dont le protoplasme a un pouvoir osmotique supérieur à celui de la sève montante.

3.—Que la pression hydrostatique de haut en bas de la colonne d'eau contenue dans le vaisseau est annulée par les bulles d'air, tout comme la pression osmotique de bas en haut de la racine.

Cela établi, ne peut-on pas proposer l'explication suivante du mécanisme de la circulation?

En vertu de la seule osmose, le liquide pénètre dans la racine, se rend aux vaisseaux, et y circule aussi longtemps que le chemin est libre. Qu'une bulle d'air se présente entravant la route, la sève, sollicitée par le voisinage du protoplasme des cellules vivantes, passera à travers les sculptures lignifiées des vaisseaux, cheminera dans le protoplasme du parenchyme le temps qu'il faudra pour éviter l'obstacle, ne pénétrant de nouveau à l'intérieur des vaisseaux que lorsque la pression y deviendra suffisante, c'est-à-dire supérieure à celle du protoplasme. Cette façon d'interpréter la circulation que nous embrassons comme plus satisfaisante, est celle de nombreux biologistes, entre autres: Leclerc du Sablon (cf. Le rôle de l'osmose en Biologie).

Conclusion

Le mécanisme de la circulation est fondé sur deux faits d'ordres différents:

1.—La non-transmission mécanique des pressions: ce qui limite la double action aspirante-refoulante de la feuille et de la racine.

2.—La transmission indéfinie des pressions osmotiques par l'intermédiaire des cellules vivantes.

A Travers les Revues.

Le capital acide phosphorique dans l'exploitation agricole.

L'Allemagne est, comme on le sait, un pays où se pratique une culture perfectionnée et intensive. Elle possède chez elle des gisements inépuisables de sels potassiqus et des ressources illimitées en composés azotés qu'elle obtient sous forme de sulfate d'ammoniaque de récupération, au cours de la distillation de la houille, et, d'avantage encore, depuis l'époque de la guerre, à l'état de sels ammoniacaux ou autres composés azotés synthétiques qui font l'objet d'une grande industrie nationale. Par contre, quelque bien doté que soit l'empire germanique en ce qui concerne les deux premiers éléments mentionnés, il souffre, depuis le début du grand conflit, d'une véritable famine d'acide phosphorique.

e possédant aucun gisement de phosphates inéraux qui puissent entrer en ligne de ompte, il est pratiquement obligé d'importer presque totalité de son P_2O_5, d'autant plus ı'il y a encore à tenir compte que ses ressurces en scories de déphosphoration ont andement diminué, par suite de la perte des gions métallurgiques de la Lorraine, andes productrices de ce sous-produit. Or, durant la guerre, ses importations furent itomatiquement coupées, depuis la fin des ostilités, les déplorables conditions monéires furent un autre obstacle à toute importion de matériaux phosphatés de l'étranger.

Aussi, malgré les nombreuses recherches et avaux exécutés par les stations expérimenles allemandes pour trouver un palliatif à situation, il semble bien que le déficit en 205 par rapport aux autres éléments conmmés devient très manifeste. Le fait resrt notamment d'une communication faite ır le professeur Ehrenberg à la "Société d'griculture de Breslau", en février 1924, et ommentée par Wilhelmi dans la revue: Deutsche Land wirtshaftliche Presse", no. 14, 147, 1924, rapport dont nous trouvons ailleurs un résumé dans "Annales de la ience agronomique française et étrangère", o. de mai-juin 1924, p. 206. D'après Ehrenerg donc, des analyses pratiquées sur des miers recueillis durant l'hiver 1920-1921 nt indiqué à peu près les mêmes proportions azote et de potasse que dans les fumiers avant guerre, tandis que la teneur en P205 trouvait être réduite au tiers des moyennes autrefois. Cet abaissement du pourcentage acide phosphorique serait attribuable à la minution de la qualité des fourrages reltés sur des sols n'ayant pas reçu d'applicaons d'engrais phosphatés. Suivant des exériences poursuivies autrefois par Wagner, serait démontré que lorsque le foin indiıe une richesse de 0.65% en P205, les prairs en sont suffisamment pourvues, mais qu'issitôt que la proportion descend en dessous ce chiffre, il devient nécessaire de faire des plications d'engrais phosphatés.

Or, par suite de la disette d'acide phosorique régant en Allemagne, depuis la ıerre, les prairies ont été privées de cet ément, les foins qu'elles produisent se sont leur tour appauvris en acide phosphorique comme de raison, les fumiers qui en proviennent, également. D'autre part, les expériences de fumure conduites par l'auteur, au cours de l'année 1922, sur 31 prairies distribuées un peu partout dans le pays, auraient démontré que 28 d'entre elles, soit 93%, étaient déficitaires en P205, et sur 52 prairies étudiées en 1923, trois seulement furent trouvées satisfaisantes au point de vue de la richesse en P205.

Aussi l'auteur en conclut qu'on peut présumer que le déficit en acide phosphorique est devenu général et que l'application d'engrais phosphatés sur les prairies s'impose pour conserver un capital normal d'acide phosphorique dans l'exploitation agricole.

Ces considérations nous démontrent donc encore une fois que, dans le problème de l'emploi des engrais phosphatés, il y a lieu d'attacher une grande importance au facteur augmentation de la qualité des fourrages.

Souvent, en effet, l'action de l'acide phosphorique est peu sensible à l'œil par une augmentation de volume de la récolte, alors qu'elle se manifeste surtout par une valeur nutritive plus grande.

Ceci est un fait dont il y aura aussi toujours à tenir compte dans la pratique de la fertilisation des sols de la province de Québec.

Le Chlorure de calcium dans l'alimentation du bétail

L'importance de l'alimentation minérale, des animaux, quoique signalée depuis longtemps, s'impose de plus en plus depuis quelques années et tend à se placer au premier plan des préoccupations des spécialistes en la matière. Comme le disait le Dr. Shutt, Chimiste du Dominion, dans une des dernières circulaires des "Conseils pour la Saison"; "Le besoin de substances minérales est à l'ordre du jour comme l'ont été tour tour, la nécessité d'avoir une quantité suffisante de calories dans le régime, une relation nutritive satisfaisante et une bonne quantité de vitamines."

De plus, il est bien connu que de tous les éléments minéraux qui entrent dans la composition des tissus animaux, c'est le calcium qui est le plus important. Lorsque les animaux ne reçoivent pas de fourrages naturellement riches en calcium, tels que le sont particulièrement le trèfle et la luzerne, il devient

souvent nécessaire de leur fournir cet élément, sous une forme spéciale, comme supplément de ration Jusqu'ici on s'est contenté de leur administrer du calcium à l'état de carbonate (craie), de phosphates moulus qu'on a l'habitude de mélanger, à l'état de poudre, à la ration ordinaire des jeunes animaux, par exemple, pour favoriser l'accroissement du squelette, ou des vaches laitières, pour subvenir au prélèvement de calcium faits par le foetus ou la lactation. Mais on reproche à la craie ou carbonate de chaux, qui est le composé calcique le plus employé à cet effet, plusieurs inconvénients. Ainsi elle se dissout surtout sous l'action des acides du suc gastrique et détermine ainsi la neutralisation de celui-ci. Or, ces acides sont nécessaires à la bonne digestion des aliments et particulièrement à celle des matières protéiques. L'action moins active du suc gastrique qui en résulte serait encore une cause de développement exagéré des bactéries dans l'estomac. La preuve de ces inconvénients a, parait-il, été faite au cours d'expériences d'alimentation avec des porcs, dont les uns reçurent une ration de mais et de poudre de sang et les autres la même nourriture avec de la craie en plus. Or ceux-ci se développèrent moins bien que les porcs qui ne reçurent pas de craie en supplément et dont la ration était cependant déficitaire en matière minérale.

C'est pourquoi, O. Loew, dans la revue "Suddeutsche landwirtschaftliche Tierzucht" (Revue d'Elevage, de l'Allemagne du sud), Munich, 27 janvier 1922, préconise l'emploi du chlorure de calcium $CaCl_2$, de préférence au carbonate $CaCO_3$, comme aliment calcique pour les animaux. Le $CaCl_2$ coute un peu plus cher que la craie, mais il reste cependant toujours une matière d'un prix fort modique puisqu'il constitue, en quantités énormes, un déchet de la fabrication de la soude par le procèdè Solvay et s'accumule même en moncaux inutilisés autour des grandes usines de carbonate de soude.

D'autre part, il faut des quantités beaucoup moindres de $CaCl_2$ pour produire le même effet que le $CaCO_3$, Le premier sel est entièrement soluble, en effet, tandis qu'une proportion relativement faible du $CaCO_3$ est attaquée et dissoute par les sucs au cours du passage à travers le tube digestif, la plus grande partie étant entrainée dans les déjections solides.

Il est évident aussi que le $CaCl_2$ n'a pas l'inconvénient de neutraliser l'acidité normale de l'estomac et, suivant O. Loew, il possèderait encore l'avantage de combattre certaines affections déterminées, telles que la diarrhée, alors que le $CaCO_3$ est dépourvu de cette propriété. La supériorité du $CaCl_2$ sur le $CaCO_3$ se serait d'ailleurs, suivant l'auteur mentionné, amplement confirmée au cours d'expériences d'alimentation.

Ainsi, chez les porcs surtout, l'emploi de $CaCl_2$ amène de notables augmentations de poids.

Dans des essais comparatifs, faits sur des lots de jeunes vaches, l'augmentation en poids vif constaté à la suite d'absorption de chlorure de calcium aurait été de 126 kgr. contre 100 kgr. seulement avec du carbonate de chaux.

Au cours d'autres expériences pratiquées sur 15 vaches, il a été enregistré une augmentation en poids de 10% pour les animaux traités au chlorure de calcium, contre 8.5% pour ceux ayant reçu de la craie. En ne tenant compte que des 6 animaux les plus jeunes de ce dernier groupe, les augmentations en poids furent de respectivement 20.5% avec le $CaCl_2$ contre 15.3% avec le $CaCO_3$.

Il faudrait donc conclure de tout ceci que le $CaCl_2$ est manifestment supérieur au $CaCO_3$ comme aliment calcique pour les animaux, surtout lorsque ceux-ci sont jeunes.

H.M.N.

LA NOUVELLE SECTION DE STE-ANNE DE LA POCATIERE

Le regain de vitalité du groupe Canadien français de la C.S.T.A. vient de se manifester par l'apparition d'un rameau nouveau: la section de Ste-Anne de la Pocatière qui s'est constituée définitivement, dans le courant du mois dernier.

Pour cela, la section de Québec a du céder une partie de son effectif, sacrifice sensible comme le départ de l'enfant qui devenu grand quitte le foyer pour en établir un ailleurs. Qu'elle s'en console cependant en songeant que ce n'est là, en somme, qu'un indice de croissance et de prospérité, un motif de nouveaux espoirs, et une raison de bienfaisante émulation pour l'activité de notre association dans toute la province.

Il n'y a pas de doute, notamment, que la formation de ce groupement supplémentaire nous ralliera bien des éléments désirables qui jusqu'ici s'étaient abstenus en raison de leur éloignement d'un centre régional d'attraction

ès aujourd'hui, la section de Ste. Anne de Pocatière compe 33 membres. Elle a élu bureau suivant, lors de sa réunion de conitution: Président, R. P. Charbonneau, asstant à la ferme expérimentale de Ste. nne de la Pocatière. Vice-Président: J. A. odbout, professeur à l'Ecole d'Agriculture Ste. Anne. Secrétaire-Trésorier: Elzéar ampagna, professeur à l'Ecole d'Agriculture Ste. Anne.

Parmi ceux qui prirent la parole au cours cette première réunion mentionnons: Ls. h. Roy, vice-président de la C.S.T.A., parnt au nom de la section de Québec, et Fred. rindley, le sympathique secrétaire général ont le premier discours français, au nom de ute la C.S.T.A., fut unanimement apprécié.

SECTION DE MONTREAL

Le premier diner causerie, de l'année comencant en septembre, a eu lieu le samedi 10 ctobre, dans le nouvel hôtel du Cercle uniersitaire, au numéro 361 de la rue Sherrooke est.

Malgré le temps détestable qui empêcha lusieurs membres de se rendre à Montréal, ente deux convives se pressaient autour des bles pour venir écouter le confrère Jeanharles Magnan, Agronome officiel du comté Portneuf et membre de la section de Québec.

Présenté par H. M. Nagant, le conférencier t part de ses impressions d'un voyage d'ude, en Angleterre, en France et en Belgiue, accompli au cours de l'été dernier. omme on le sait, monsieur J.-Chs. Magnan it délégué officiel de la province au Conrès national de l'agriculture française tenu Rouen; en homme qui ne perd pas son mps, il ne manqua pas d'entrer en relations vec plusieurs des personnalités les plus minentes du monde agronomique de France, lles que Jules Méline, l'economiste agricole niversellement connu, à plusieurs reprises inistre de l'agriculture, le marquis Louis de ogué, président de la Société des Agriculurs de France, et beaucoup d'autres. En elgique, il étudia surtout l'organisation de enseignement agricole secondaire et des randes coopératives agricoles telles que le oerenbond belge qui a son siège principal Louvain. C'est dire que le conférencier eut occasion de discuter et de comparer de manre très intéressante les grands problèmes gricoles qui concernent le Canada, la France, la Belgique.

Aussi l'attention et l'intérêt témoignés à l'exposé piquant, original et empreint de ce caractère de profonde conviction, propre à notre confrère, seront le meilleur témoignage que l'ami Jean-Charles Magnan ne s'est pas dérangé en vain pour faire le voyage de St-Casimir de Portneuf à Montréal.

Ce fut le camarade Gérard Tremblay, professeur à l'Institut Agricole d'Oka, qui se chargea de remercier le conférencier au nom de l'assemblée.

Après la causerie, plusieurs autres points à l'ordre du jour furent discutés, notamment l'organisation d'un grand banquet de toutes les sections conjointes de la province de Québec, à l'occasion de l'exposition de pommes qui doit avoir lieu à Montréal les 4-5-et 6 novembre prochain.

BUREAU DE PLACEMENT DE LA C.S.T.A.

Nous attirons l'attention des membres et futurs membres de la C.S.T.A. sur la résolution, adoptée à la dernière Convention générale d'Edmonton, visant l'établissement d'un bureau de placement, à leur service. Ce bureau fournira des renseignements concernant les places vacantes pour techniciens agricoles et mettra les intéressés en contact avec toutes les occasions qui pourront se présenter pour eux.

L'organisation définitive en sera différée jusqu'à la clôture de la campagne actuelle de recrutement des membres, en décembre 1925. Vers cette époque, la coopération d'un chacun sera demandée pour assurer le bon foncionnement du bureau.

Nul doute que ce nouvel organisme greffé sur la C.S.T.A. arrive en son temps et soit unanimment apprécié. Les emplois officiels dans les administrations commencent à être encombrés, tandis qu'il y a des centaines de positions, souvent bien mieux rémunérées, qui pourraient être remplies par des gradués de nos instituts agronomiques, dans les industries et le commerce ayant rapport à l'agriculture.

Mais il s'agit avant tout de rechercher ces places, d'attirer l'attention des employeurs sur les avantages qu'ils auraient à engager des techniciens agricoles, pour les remplir, de préférence à des personnes dépourvues de toute connaissance spéciale en la matière. Enfin, il faudra signaler aux gradués tous les débouchés qui pourront s'offrir.

Telle sera la mission du bureau de placement organisé par la C.S.T.A.

Dominion Department of Agriculture Notes

LIVE STOCK BRANCH

In the fall of 1919 a vision which had been fathered and fostered by the Dominion Live Stock Branch was launched and the policy of Canadian Record of Performance for Poultry was put into motion. In that year 67 breeders throughout the Dominion showed their faith in the movement by entering 49,000 birds in the Service. Through the years that have followed since then, Record of Performance has recorded a steady growth, the doubt and hesitation which at first surrounded the movement have been entirely dispersed and up to September 19th of the present year, 151 breeders had entered 20,450 birds for the coming year. This too with the rules more stringent and the entries limited to larger flocks than was the case when the Service started.

It is fitting and co-incidental that on the eve of R.O.P. entering the greatest year of its history Mr. W. A. Brown, Chief of the Poultry Division of the Live Stock Branch, and originator of the plan, should address a gathering of the National Poultry Congress of the United States to explain to that body the functioning of R.O.P., its rules and regulations, its value to Canada and the value of Canadian R.O.P., stock to other countries. At the present time State and National interests in the United States are struggling to adopt some uniform policy of poultry certification and Canada with her clear cut system of R.O.P. strongly established is pointing the way. A system of official inspection of trap-nest records with certificates issued for birds laying over 150 eggs and advanced certificates for records over 225 eggs, with rigid requirements for egg size and for standard type birds, makes the Canadian system of R.O.P., as administered by the Dominion Live Stock Branch, the outstanding policy of poultry certification in the world to-day. England, as well as the United States, is closely following the work of the Service in Canada and there is strong agitation among several leading English poultrymen to adopt some such policy there.

"While the policy of Record of Performance was introduced primarily as an economic factor to further the development of th poultry industry at home", stated Mr. W. A Brown in his address before the Chicago gath ering, "it would appear that from the in terest apparent in the quality of stock accru ing from the operation of this policy that in preparing a prescription for her own condi tion, Canada has consciously or unconscious ly an antidote for the ills of the other fellow as well. In other words, in her northern grown, healthy, vigorouos stock, bred and ap proved under the national policy of Recor of Performance, Canada has an asset in an export sales way not enjoyed by any other country under the sun."

SEED BRANCH

Investigations made by the Feed Divisio of the Seed Branch indicate a need for im proved methods of handling and shipping i Canadian hay is to find a profitable market particularly in the United States, which country has for years been our best customer The extensive replacement of horses by auto mobiles within recent years has greatly re duced hay consumption in their cities. Thi is offset in some degree by an increased de mand for dairy hay in areas surrounding large urban centres, but under normal con ditions of production and consumption the disposal of low-grade hay, always a problem is becoming increasingly difficult.

Very little Canadian hay grades No. 1 o United States markets. Through late cutting or weathering it has lost its natural green colour; bales are non-uniform in size an shape and frequently lined with clover chaff cars are not neatly and uniformly loaded. I is also a common complaint that much Can adian hay shipped to southern points heat and moulds in transit or storage due to press ing while wet with snow or rain. These de fects will have to be corrected if Canadia hay is to find a continued outlet in Unite States markets in competition with thei domestic hay handled and marketed unde improved methods and in the face of a dut of four dollars per ton.

Concerning the C.S.T.A.

APPLICATIONS FOR MEMBERSHIP

The following applications for regular membership have been received during the month of October:

Ainslee, G. D. (Toronto, 1924, B.S.A.) Niagara Falls, Ont.
Allen, Wm. (Saskatchewan, 1922, B.S.A.; Cornell, 1925, Ph.D.) Saskatoon, Sask.
Bowen, G. H. (McGill, 1923, B.S.A.) Winona, Ont.
Chester, H. (British Columbia, 1925, B.S.A.) Invermere, B.C.
Conners, I. L. (McMaster, 1918, B.A.; Toronto, 1920, M.A.) Winnipeg, Man.
Craigie, J. H. (Minnesota, 1925, M.S.) Winnipeg, Man.
Doughty, J. L. (Alberta, 1921, B.S.A.; California, 1925, M.S.) Edmonton, Alta.
Dumais, A. (Laval, 1917, B.S.A.) Lennoxville, P.Q.
Dunsmore, W. G. (McGill, 1920, B.S.A.) Ottawa, Ont.
Dupré, J. G. A. (Montreal, 1919, M.V.) Ste. Anne de la Pocatière, P.Q.
Dustan, A. G. (Toronto, 1915, B.S.A.; McGill, 1922, M.Sc.)
Fraser, G. S. (Toronto, 1921, B.S.A.) Ottawa, Ont.
Giasson, L'abbé A. (Laval, 1915, B.A.) Ste. Anne de la Pocatière, P.Q.
Gosselin, F. X. (Laval, 1923, B.S.A.) Ste. Anne de la Pocatière, P.Q.
Guild, T. L. (Manitoba, 1914, B.S.A.) Regina, Sask.
Hutton, F. V. (Manitoba, 1918, B. S. A.) Rosthern, Sask.
Jacobson, W. L. (Alberta, 1920, B.S.A.) Calgary, Alta.
Lachaine, O. W. (McGill, 1922, B.S.A.) Ste. Anne de la Pocatière, P.Q.
Langelier, Gustave (Laval, 1922, D.Sc.A.) Cap Rouge, P.Q.
Leduc, A. (Montreal, 1924, B.S.A.) La Trappe, P.Q.
Long, L. C. (Toronto, 1921, B.S.A.) Athabasca, Alta.
McAra, J. M. (Alberta, 1925, B.S.A.) Calgary, Alta.
MacGregor, W. G. (Toronto, 1924, B.S.A.) Ottawa, Ont.
Neatby, K. W. (Saskatchewan, 1924, B.S.A.) Saskatoon, Sask.
Pelletier, L. G. (Montreal, 1921, B.S.A.) Huntingdon, P.Q.
Pomerleau, René (Laval, 1924, B.S.A.) Ste. Anne de la Pocatière, P.Q.
Potts, A. E. (Edinburgh, 1912, B.Sc.; Cornell, 1914, M.S.A.) Saskatoon, Sask.
Potvin, J. B. (Laval, 1918, B.S.A.) St. Jean Port Joli, P.Q.
Siemens, H. J. (Manitoba, 1925, B.S.A.) Altona, Man.
Stacey, E. C. (Alberta, 1924, B.A.) Edmonton, Alta.
Ward, A. S. (Alberta, 1921, B.S.A.) Edmonton, Alta.

Up to the present the following have enrolled as Student Members:

At the Ontario Agricultural College: W. B. Reynolds and J. E. D. Whitmore.
At Macdonald College: W. M. Levine and C. Perrault.
At the University of Alberta: R. H. Bedford, E. Johnson, C. W. Keer, J. M. Manson, W. S. Morrison, H. Phillips and W. Robinson.
At Ste. Anne de la Pocatière: G. Ampleman, R. Caron, G. Ducasse, F. Godbout, M. Hudon, M. R. Leblanc, A. Mathieu, J. Michaud, D. Pomerleau.

MEMBERSHIP CAMPAIGN

The list of membership applications listed above gives some idea of the results of the campaign launched a month ago. The total membership in the Society has now passed eight hundred and there is every likelihood of a further heavy increase during November. A campaign is now being organized in western Ontario where there are still many non-members.

At the close of the membership campaign on December 31st, a complete list of members, with their addresses, will be printed

and given free disribution. The Bureau of Employment which was proposed at the Edmonton Convention will then be organized and should be ready for active operation by April 1, 1926.

Members who have not yet paid their fees for the current year are again reminded that, during the present year, fees are at the rate of 50 cents per month from the date on which paid-up membership expired, to June 1, 1926. This plan will bring all next year's fees due on a uniform date and simplify collections considerably.

EASTERN ONTARIO BRANCH

This local, with headquarters at Ottawa, opened its winter activities with a dance at the Chateau Laurier on October 23rd, which was well attended. A business meeting is to be held on November 13th for the purpose of appointing committees to attend to details of the Dominion Convention, which is to be held at Ottawa next June. Regular monthly luncheons will be held on the first Friday of each month during the coming winter. The first one, on December 4th, will be addressed by Dr. O. D. Skelton, Under-Secretary of State.

WESTERN ONTARIO BRANCH

An Executive meeting of this local was held at Toronto on October 15th. It was attended by the General Secretary and by Mr. J. A. Carroll, President of the Provincial O.A.C. Alumni Association. It was decided to hold a joint banquet at the King Edward Hotel, during the Royal Winter Fair, on November 18th. This Banquet, which was first organized in 1923, appears to be established as an annual event.

The Western Ontario local has appointed a Membership Committee, with Mr. W. H. J. Tisdale as chairman, and a campaign is being undertaken immediately. As an objective, the Committee will attempt to enrol two hundred new members before the end of the year.

The branch is planning to hold regular monthly meetings at the Engineers Club, Toronto.

MONTREAL BRANCH

This branch opened the season with a luncheon at the University Club on October 10th, when the speaker was Mr. J. C. Magnan, County Agriculturist at St. Casimir, P. Q. A full report appears in the French sec tion of this issue.

The Montreal branch is arranging a spec ial banquet for November 6th, and will ac as hosts to all C.S.T.A. members attendin the Montreal Apple Show. It is expecte that one hundred members will be prsent The speakers will be Dr. J. H. Grisdale, Dom inion Deputy Minister of Agriculture, Dr A. T. Charron, recently appointed as Assist ant Deputy Minister and Mr. L. P. Roy, Chie of the Field Husbandry Division of the Que bec Department of Agriculture. Member who are planning to attend this banquet ar asked to communicate with Prof. Gustav Toupin, La Trappe, P.Q., who is secretar of the Montreal branch.

STE. ANNE DE LA POCATIERE

The General Secretary attended a meetin at the Agricultural School, Ste. Anne de l Pocatière, P.Q., on October 1st, when a new branch of the Society was organized. The branch at Quebec City sacrificed a number o members to the new local, which is the fourt branch to be organized in the Province. Wit the exception of the Macdonald local, all th branches are composed of French-speakin members. The present distribution of mem bers in the Province of Quebec is as follows Macdonald, 54; Montreal, 62; Quebec, 57 Ste. Anne de la Pocatière, 33.

The officers of the new local branch a Ste. Anne are: President, Roger Charbon neau; Vice-president, J. A. Godbout; Secre tary, Elzear Campagna.

MAGAZINE DEVELOPMENT

The present issue indicates the possibilitie of increasing the size of *Scientific Agricultur* to provide for articles of more than usua length. The article by Professor Wyatt an the joint article by Professor Kirk and D Goulden could not have been published i one issue of the ordinary size and eight page have been added in order that the usual fea tures of the magazine could be included. I has often been suggested that *Scientific Agri culture* should be increased in size and tha articles covering a wider range of subject should be published. The Society, howeve has always been handicapped financially an

even at present is not in a position to develop the magazine in the manner suggested, except in occasional issues.

Few members realize that for the past three years the official organ of the Society has carried more than 60 per cent of the Society's total operating expenses and that less than forty per cent is contributed by membership fees. This ratio has to be maintained and fees can only be reduced by increasing the number of members. The present membership campaign has been undertaken in the hope that an annual fee of $5.00 can be put into effect in June, 1926.

VACANCIES IN THE DOMINION DEPARTMENT OF AGRICULTURE

The following vacancies in the Dominion Department of Agriculture are now being advertised by the Civil Service Commission at Ottawa, and interested members should immediately file their applications. Forms can be obtained from the Postmasters at Prince Rupert, Vancouver, Victoria, Edmonton, Calgary, Regina, Saskatoon, Winnipeg, Quebec, Fredericton, St. John ,Charlottetown, and Halifax, or the Secretary of the Civil Service Commission:—

List No. 288. Senior Plant Pathologist, Experimental Farms Branch, at Winnipeg. Salary $2,640 per annum, with increases of $120 per annum up to a maximum of $3,120. The qualifications call for graduation in science, with post graduate specialization in botany, plant pathology or bacteriology; at least four years of experience as Assistant Plant Pathologist or two years of experience as Plant Pathologist, or in work of an equivalent character and standard; knowledge of farming; research ability, supervising ability; good address.

The positions of Field Husbandman and of Assistant Agrostologist, in the $1920 to $2400 class, are also being advertised, both in the Experimental Farms Branch. Post graduate training in taxonomy of the higher plants is required in the latter position, and post graduate training in field husbandry and soils is preferred in the former.

Among the positions advertised by the Civil Service Commission last month, we noticed that the same initial salary ($1,500) was offered for an Assistant to the Superintendent at an Experimental Farm and for a Poultry Promoter in the Live Stock Branch. A comparison of the qualifications for these two positions is interesting:

Assistant to Superintendent—Graduation in agriculture from a college of recognized standing, with specialization in field husbandry; preferably post graduate experience in field husbandry and animal husbandry investigational work; experience in practical farming; supervisory ability; tact and good address; good physical condition.

Poultry Promoter—At least high school education, and preferably two years training in an agricultural college of recognized standing; knowledge of the poultry business gained through experience in the breeding and raising of poultry; tact, good address, and ability to deal with the public.

These salaries and qualifications are obviously in accordance with Civil Service classifications, but they appear to be grossly inconsistent.

DR. SAUNDERS' WESTERN TRIP

Dr. Charles E. Saunders, formerly Dominion Cerealist, and well known as the originator of Marquis wheat, has recently addressed a number of C.S.T.A. meetings in western Canada. He gave the members much interesting information concerning his experiences in France, where he spent two years attending lectures at the Sorbonne. Dr. and Mrs. Saunders have taken up residence at Ottawa.

NOTES

W. V. Longley (O.A.C. '11) is taking graduate work in Agricultural Economics at the University of Minnesota. His address is 1254 Raymond Ave., St. Paul. He was formerly in charge of sales of certified seed for the Minnesota Potato Growers' Exchange.

E. A. Atwell (Macdonald '23) has been transferred from the Dominion Laboratory of Plant Pathology at Charlottetown, P.E.I., to the Lab. at Fredericton, N.B.

J. S. Shoemaker (O.A.C. '21) has recently been appointed to the staff of the Horticulture Department of the Ohio Experiment Station, Wooster.

W. H. Brittain (Macdonald '11) sailed from New York on October 24th and will spend eighteen months travelling through Europe, Asia, India and foreign countries too numerous to mention. He has been granted leave of absence by the Nova Scotia Department of Agriculture and engaged by the American Cyanamid Company to develop new uses for Calcium Cyanide. Dr. Brittain has been Provincial Entomologist for Nova Scotia since 1913.

R. Innes (Macdonald '11) has been appointed Secretary-Treasurer of "Appo-Crisps Limited", with headquarters at Kentville, N.S. This refutes our statement last month that Mr. Innes had been appointed Deputy Minister of Agriculture for Nova Scotia.

"Appo-Crisps Limited" is a new company which will manufacture a breakfast food composed of a combination of fruit and cereals.

W. A. Maw (Macdonald '20), Head of the Poultry Department at Macdonald College, received his M.Sc. degree from McGill University on October 6th.

MEMBERSHIP INTEREST

At this stage in the development of the C.S.T.A., there is nothing more needed than membership interest and co-operation. During the past five years the Society has always been handicapped by an apparent lack of professional pride on the part of many agricultural graduates and an apparent disinclination to assist in bringing the organization to happy maturity. For that reason particularly, development has been slower than it would have been otherwise. There are those, of course, who have given of their time and energy to assist the C.S.T.A. in many ways, but as a professional body, the members seem to lack some of those "boosting" qualities which are so characteristic of other professions.

At the present time the Society is conducting a membership campaign, with the object of having 1,000 members enrolled by December 31st, when a complete list will be printed and distributed. How many members are helping in this campaign? It is safe to say that every member knows a non-member, and if he would make use of his opportunities, he could enrol a new member.

We passed the 800 mark a week or two ago. Let's get together, pass the 900 mark in November and reach our objective before the new year. It can be done if each member will help, but it cannot be done if the prospective member is reached only by circulars and propaganda through the mails.

We are going to meet in Convention at Ottawa next June. We organized there in 1920 and the 1926 Convention will be our homecoming after six years of growth. We promise to re-appear as a rather strapping youngster and to be a credit to our calling, but we ought to be almost 100 per cent representative of our class.

Come on, boys, and lend a helping hand!

Self-Pollination of Sweet Clover.

L. E. KIRK

Professor of Field Husbandry, University of Saskatchewan, Saskatoon

Studies which throw light on the problems f fertility of crop plants are of vital in- erest to the plant breeder. With many of ie newer crops and some of the older nes, the information is quite inadequate. his appears to be the case with sweet clover, plant which has only recently come into rominence as a cultivated crop in this coun- y. Those engaged in the improvement of veet clover are still asking such questions as whether the flowers are capable of self- ertilization and to what extent they are de- endent on the visitation of insects for seed roduction.

Coe and Martin (1) in published results of n extensive series of pollination studies with veet clover, present some interesting data n the effect on seed production of excluding ll insects from the plants during the entire owering period. In their review of the lit- rature they point out that Darwin, working ith *Melilotus officinalis*, found that the flow- s are self-pollinated only to a small extent, hile Kirchner working with *Melilotus alba* und self-pollination to occur generally. nuth is mentioned as listing *M. officinalis* as ne of the best known cases of self-fertility plants. These differences of opinion are f interest in the light of the results which ere obtained with *M. alba* in comparison ith *M. officinalis* in the experiments herein ported.

The results obtained by Coe and Martin 1) working with *M. alba* are at variance ith the results presented in this paper. At rlington and also at Ames they enclosed ree plants together in a cheesecloth cage. hese produced an average of only 0.42 pods r raceme. In order to determine whether e shading of the plants in the cheesecloth vered cages had caused the production of e seed to be reduced, a large cage having ass sides and top but with ends covered ith cheesecloth to permit ventilation, was aced over nine plants at Ames. These produced an average of 0.31 pods per raceme. The different plants in the latter experiment varied in number of pods from 0.1 to 0.45 to the raceme. Approximately the same results were secured by both methods of caging.

The above results are comparable with those secured from two plants which were subject to insect visitation at all times. These grew on the same plots, one at Arlington and one at Ames, as those on which the plants were caged. The counts included all of the racemes on each plant. One of these produced 196 racemes with an average of 20.4 pods each and the other 239 racemes with an average of 41.6 pods, making an average for the two plants of 31 pods per raceme. The figures are stated to be much lower than if the racemes had been taken only from the upper branches.

From their study Coe and Martin (1) conclude that "spontaneous self-pollination does not occur regularly as stated by Kirchner".

In 1924 the writer made a preliminary experiment similar to those just reviewed. A single plant *M. alba* was caged before the flowers opened with a good grade of cotton sheeting. This was not removed until most of the seed was mature. The podding of the caged plant appeared to be about as good as that of the plants outside of the cage. Thirty well developed racemes from the upper branches of the caged plant were collected and a similar number from a typical plant just outside the cage. These gave average numbers of 45.6 and 47.5 pods per raceme respectively.

The results of the single test in 1924 seemed to warrant more extensive investigation. Accordingly in 1925 twenty-one cotton cages were used to enclose fourteen single plants and seven groups of plants of sweet clover. In addition eighty-two large sized glassine bags ($3\frac{1}{2}$ x $8\frac{1}{2}$) were used for enclosing racemes on as many plants. The object in both cases was to thoroughly exclude insects of all kinds.

eceived for publication, Oct. 15, 1925. Ed.

Fig. 1. Cotton cages enclosing individual plants of sweet clover for the purpose of excluding insects during the flowering period.

The cages were approximately three feet square, five feet high and made of medium weight cotton with a weave of 52 strands to the inch. The bottoms were saturated with oil and sunk a few inches into the soil, the tops drawn together and tied like a grain sack. The plants were enclosed July 14th before any of the flowers had opened and the cages removed August 17th after the pods had fully developed but before they had ripened.

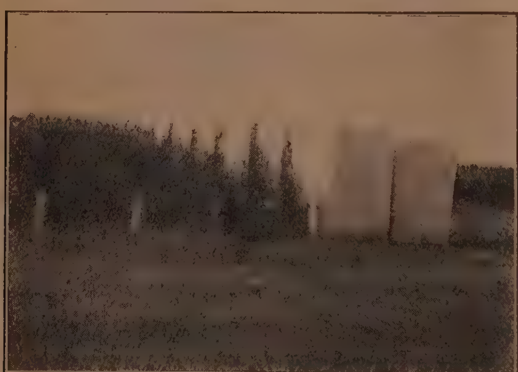


Fig. 2. Cotton cages, each enclosing several plants of sweet clover for the purpose of excluding insects during the flowering period.

Of the 14 plants which were caged separately, nine belonged to the species *M. alba* and six to *M. officinalis*. The former included three and the latter two different strains. The plants which were caged in groups all belonged to the *M. officinalis*.

The plants on which glassine bags we used included two strains of *M. alba and o* of *M. officinalis*. Forty-two bags were us on the former and 40 on the latter. On count of the fact that the bags had to placed over the racemes when they we very young, too many racemes sometim developed within the bags, and the resulti crowding undoubtedly tended to reduce t number of pods produced. The results, ho ever, for *M. officinalis* are about the sa whether few or many racemes were enclos That lack of space cannot be considered important reason for the uniformly l setting of seed by *M. officinalis* is shown the fact that one plant of *M. alba* produc 40 racemes with 526 pods in a single b and another 26 racemes with 378 pods.

Of the 82 bags used only 32 survived wi out injury. The balance were discarded. U fortunately a disproportionate number of jured bags were on *M. alba* plants. Glass is rather fragile and ruptures easily in high wind. With the experience secured this season's work the method employed enclosing flowers could undoubtedly be u with greater success.

Approximately 50 racemes were collec from each caged plant. These were ta at random, except that only fully develo racemes, and as far as possible those the same stage of maturity were select With the glassine bags all of the racen

ere included for calculating the average umber of pods, although many of them ere small and underdeveloped.

ig. 3. Typical racemes of *Melilotus officinalis* (left) and *Melilotus alba* (right) with glassine bags removed to show the relative amount of seed produced when insects are completely excluded during the flowering period.

Table I gives the average number of pods roduced per raceme on each of the plants rotected from insect visitation with cotton cages during the entire flowering period. The figures are averaged from both *M. alba* and *M. officinalis*. The averages are also given for unprotected plants of both species as a basis of comparison.

Table II gives the average number of pods produced per raceme for plants of both species, the flowers of which were protected from insect visitation by glassine bags. Twenty-one of the 40 bags of *M. officinalis* yielded no seed; that containing the most seed gave an average of 0.4 pods per raceme.

From the data presented in the above tables it will be seen that *M. alba* produced an average of 34.91 pods per raceme when enclosed in the cotton cages as compared with 66.43 pods per raceme for open-pollinated plants. *M. officinalis* on the other hand produced only 2.6 pods per raceme as compared with 63.88 pods for open-pollinated plants. The difference between the two species is very pronounced and consistently in favour of *M. alba*.

Table II shows a difference which is even more striking. The average number of pods

Table I. Production of sweet clover seed by plants protected from insect visitation with cotton cages during their entire flowering period at Saskatoon, Saskatchewan, in 1925.

	MELILOTUS ALBA.			MELILOTUS OFFICINALIS		
Plant	No. of racemes counted	Total No. of pods	Average No. of pods per raceme	No. of racemes counted	Total No. of pods	Average No. of pods per raceme
No. 1	50	2821	56.43	50	32	0.64
No. 2	50	1322	26.44	50	498	9.90
No. 3	50	766	15.32	50	99	1.98
No. 4	50	2095	41.90	50	40	0.80
No. 5	50	1865	37.30	50	102	2.04
No. 6	50	2095	41.90	50	11	0.23
No. 7	50	2099	41.98			
No. 8	30	541	18.03			
Average			34.91			2.60
Plants Unprotected	100	6643	66.43	76	4855	63.88

Table II. Production of seed by racemes of sweet clover plants which were protected from insect visitation by glassine bags at Saskatoon, Saskatchewan, in 1925.

Species	No. of Bags Placed	No. of Uninjured Bags	Total No. of Racemes Enclosed	Total No. of Pods	Average No. of Pods per Raceme
Melilotus alba	42	5	84	1326	15.79
Melilotus Officinalis	40	27	409	18	0.04

per raceme for those enclosed in glassine bags was 15.79 for *M. alba* as compared with 0.04 pods for *M. officinalis*. The difference is very significant when we consider that the highest average for any individual plant of the latter species was 0.4 pods per raceme.

It has already been indicated that several plants of *M. officinalis* were enclosed in each of six cotton cages. The original intention was to prevent cross-pollination and thus secure a supply of seed which would be the result of self-fertilization. No difficulty was anticipated in this matter, it being expected that yellow sweet clover would probably behave as did the white flowering plant which was caged in 1924. The facts proved quite the reverse. By a careful examination of these plants and by counting a large number of racemes it was estimated that an average of about two pods per raceme was produced. The results are in close agreement with those obtained from the individually caged plants of the same species.

The data presented seems to leave little doubt that *M. alba* and *M. officinalis* differ widely in their ability to set seed without the aid of insects. If this be the case it is natural to suppose that this difference between the two species is a possible explanation for the conflicting statement of previous investigators, for both Darwin and Knuth, who believed that sweet clover required the visitation of insects for seed production were referring in their statements to *M. officinalis* On the other hand, Kirchner, who found that spontaneous self-pollination occurs generally worked with *M. alba*.

CONCLUSIONS

Melilotus alba is highly self-fertile and will set seed freely without the visitation of insects. Self-fertilization may be the rule, but not necessarily so, under field conditions in Saskatchewan.

Melilotus officinalis is probably unable to set seed freely unless cross-pollinated by insects; or the plants may be sufficiently sensitive to the artificial conditions incident to caging with cotton or glassine so as to prevent seed setting when insects are excluded by these materials.

REFERENCE

1. Coe, H. S. and Martin, J. N. Sweet clover seed. Part I. Pollination studies of seed production. U.S. Department of Agriculture, Bulletin 844, 1920.

THE WORLD'S WHEAT SITUATION

Estimates of the production of wheat in almost every country of the Northern Hemisphere have been received and published by the International Institute of Agriculture. Belgium, Denmark, Scotland, Ireland and Portugal are the only countries yet to be heard from, and their crops are negligible in considering the world's production. The total yield of wheat this year in the Northern Hemisphere, excluding Russia, is now estimated at 2,909,379,000 bushels as compared with 2,644,216,000 in 1924 and 3,014,596,000 in 1923. This year's production is thus 265,000,000 bushels more than that of last year but 106,000,000 less than the huge crop of 1923.

The total wheat crop of Europe, outside of Russia, is 1,313,649,000 bushels against 1,028,432,000 last year and 1,222,256,000 in 1923, an increase of 286,000,000 bushels over last year and of 91,000,000 over 1923.

In September the Soviet Government estimated the wheat crop of Russia, including Siberia, at 661,000,000 bushels against 382,000,000 in 1924. Since then they have stated that this estimate should be reduced by twenty per cent. That the crop was greatly overestimated is now certain as there has so far been very little export of wheat from Russia, and very bad weather during harvest must have seriously reduced the quality of the grain. It is also stated on good authority that the crops of several of the Balkan States have been overestimated. At any rate these countries have done very little exporting so far.

In spite, then, of the large increase in the total reported production of the Northern Hemisphere, Canada is in a good position to dispose of her huge crop of 422,000,000 bushels, the second largest reaped in this country. The lack of exports from Russia and the Balkans, and the very short crops in India and the United States, have left the export market for the autumn months almost entirely to Canada, whose splendid hard spring wheat is in great demand.

Preliminary Experiments on the Control of Leaf and Stem Rusts of Wheat by Sulphur Dust.*

D. L. BAILEY and F. J. GREANEY

Dominion Rust Research Laboratory, Manitoba Agricultural College, Winnipeg, Man.

In 1924 Kightlinger (†) reported that he had found sulphur dust strikingly efficient in controlling cereal rusts in some preliminary experiments which he had carried out in New York State. This indicated the desirability of determining the efficiency of sulphur dust in controlling wheat rust in Western Canada. Accordingly, some preliminary experiments were carried on by the Dominion Rust Research Laboratory at Winnipeg in the summer of 1925 to test the efficiency of sulphur in controlling leaf and stem rusts of wheat under local conditions. It was hoped to determine in a preliminary way (a) the number of applications necessary to control rust, (b) the optimum rate of application of the dust, and (c) the most effective time of application.

Experimental Methods

On May 21st a block of heavy black clay loam, which had been summer-fallowed the previous year, was seeded with Marquis wheat of good quality. The late sowing on heavy summer-fallow reproduced the conditions under which rust usually does the most serious injury in Manitoba. A uniform stand was secured and growth was vigorous. The block was divided about the middle of June into eleven fortieth-acre plots separated from one another by three-foot pathways.

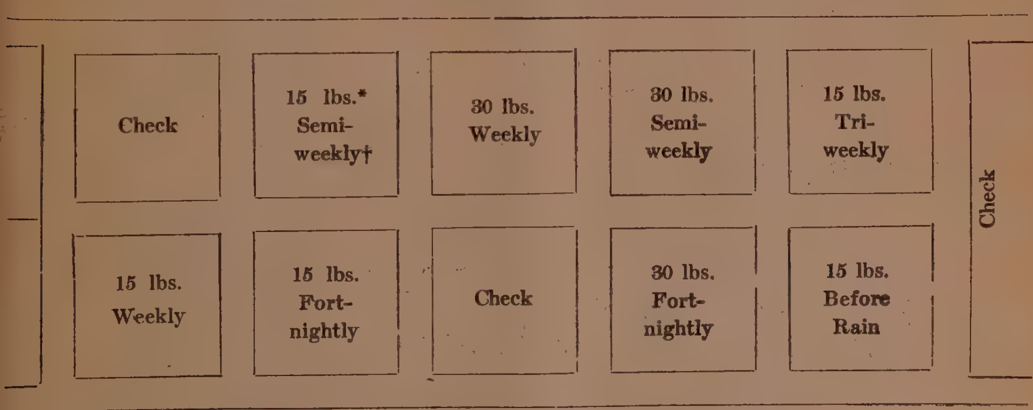
Dusting operations were begun on July 2nd. At that time no stem rust had been found at Winnipeg, although a single pustule of the uredinial stage had been reported on an early wheat at the Morden Experiment Station in Southern Manitoba on June 23rd. At the time dusting was commenced a light scatter-

* The authors express their appreciation to Professor H. H. Whetzel, Cornell University, for suggestions as to materials and methods of application, as well as for making available unpublished material collected at his station.

† Kightlinger, C.V. Preliminary Studies on the Control of Cereal Rusts by Dusting. Phytopath. 15: 611-613. 1925.

Figure I

Distribution of Various Plots in Sulphur Dusting Experiment with the Rate and Frequencies of Application of Sulphur Dust.



* The rate of application of sulphur dust is indicated in lbs. per acre.
† Frequency of application of sulphur dust.

ing of leaf rust was becoming general around Winnipeg. Before the end of the growing period, a severe epidemic of both leaf and stem rust developed on the College farm.

Three of the eleven fortieth-acre plots remained untreated as checks. One plot was dusted at the approximate rate of 15 lbs. sulphur dust per acre at each of the following frequencies: (1) One dusting every two weeks, (2) one dusting every week, (3) two dustings every week, and (4) three dustings every week. A parallel series dusted at the rate of 30 lbs. of sulphur dust per acre was carried out, except that in this series the plot receiving three applications per week was omitted. One additional plot was dusted at the rate of 15 lbs. sulphur dust per acre whenever rain seemed imminent. The distribution of the plots is shown in figure 1.

The sulphur dust was applied by means of a hand duster (Niagara Blower gun No. 42). This machine was satisfactory in regard to spreading the dust and applying it uniformly. It did not provide any carefully controlled means of varying the rate of application so that the rates mentioned throughout are only close approximations.

The sulphur dust was Niagara Sulphodust No. 134, supplied by the Niagara Sprayer Co., of Middleport, N.Y. It was guaranteed to contain at least 92% sulphur and not over 8% inert ingredients.

Data were taken on leaf rust infections on August 10th, and on stem rust infection on August 25th. In both cases percentage infections were taken, and the estimates were made according to the system followed by the United States Department of Agriculture.

At harvest time yield data were collected from the various plots by harvesting from each plot three samples, each covering one square yard in area. The average of the three samples was taken as the yield of the plot. In addition, the weights of 1000 kernels, chosen at random from the threshed

Table I

Results of Dusting Wheat with Sulphur for the Control of Leaf and Stem Rusts.

Dusting Period July 2nd to Aug. 25th			Percentage infection of rust					
Rate of application lbs. per acre	Frequency of applications	Total number of applications	Leaf rust	Stem rust	Weight of 1000 kernels in gms.	Weight per bushel in lbs.	Canadian Government grade	Yield per acre in bushels
Check	0	0	60 (30-80)	80	18.1	49.5	5	21.3
15	Fortnightly	4	75	75	17.7	48.5	5	24.5
15	Weekly	8	65	60	24.6	56.2	3 Northern	35.1
15	Semi-weekly	17	45	50	28.8	60.0	2 Northern	43.1
15	Tri-weekly	24	15	5 (tr-15)	37.1	63.0	2 Northern	55.1
Check	0	0	85	90	15.3	44.5	Feed	11.9
30	Fortnightly	4	75	80	16.7	50.2	5	20.3
30	Weekly	8	60	75	20.5	51.0	4	24.7
30	Semi-weekly	17	20	(20-60)	31.0	64.2	1 Northern	50.8
Check	0	0	60	80	17.9	49.0	5	19.9
15	Just before rains	7	60	40 (20-75)	20.1	61.7	3 Northern	42.5

ample of each plot, were compared. To ompare still further the quality of the wheat rom the various plots, a threshed sample rom each plot was submitted to the Domnion Grain-testing Laboratory in Winnipeg. Through the courtesy of Inspector Ross these amples were graded in the regular way acording to the Dominion Government stanlard.

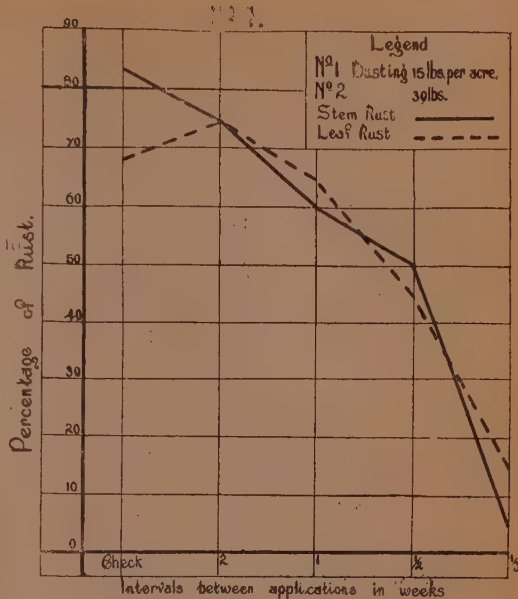
Experimental Results

The results of the experiment are sumnarized in Table 1. It is evident that the ulphur-dust treatments had in some instanes a very marked effect in controlling both eaf and stem rusts.

In the series of plots that were dusted at he rate of 15 lbs. sulphur per acre, the one reated only once every two weeks was rusted s badly as the check. Where the plot was lusted once every week, there was a signifiant reduction in the rust as compared with he checks, as well as an increase in both ield and grade. The plot which was dusted wice every week showed still further improvement in yield and grade and a further eduction in rust infection. In the plot vhich received three applications per week, here was a striking reduction in amount of ust. This plot could be distinguished even t a distance by the clean golden straw, and, n closer examination, the heads were found o be very well filled. The yield was 34 ushels per acre greater than the average of he checks, and the grade was No. 2 Northern s compared with grades of No. 5 and "Feed" or the checks.

Perhaps the most interesting plot in the xperiment was the one which was dusted ust before rains, at the rate of 15 lbs. per cre. It received a total of seven applicaons and is therefore comparable in this resect with the plots which were dusted week-. Yet the application just before rains was ery much more effective in controlling rust an the equally frequent weekly applications hich bore no relation to weather conditions.

Plate I presents graphically the relation beveen the percentage infection of leaf and em rust and the frequency of application of e sulphur dust for the two rates of applicaon. These graphs are exceedingly interesting. the first place the curves of leaf and stem



Nº 2.

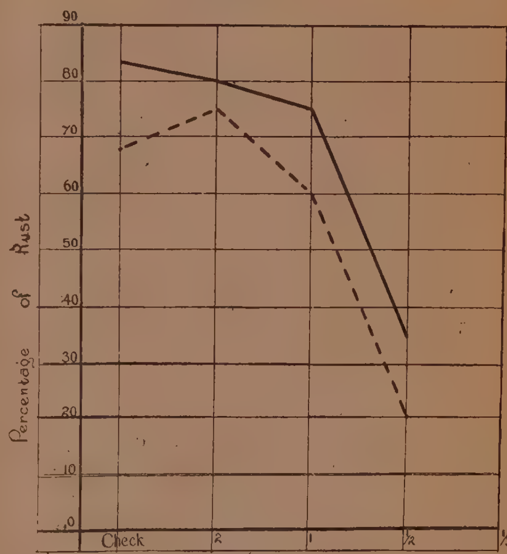


PLATE I.

No. 1—Graph showing the relation between the percentage infection of leaf and stem rusts by wheat to the frequency of application of sulphur dust at the rate of 15 lbs. per acre.

No. 2—Graph showing relation between the percentage infection of leaf and stem rusts of wheat to the frequency of application of sulphur dust at the rate of 30 lbs. per acre.

rust are so similar that they can be safely considered identical. In the case of the two

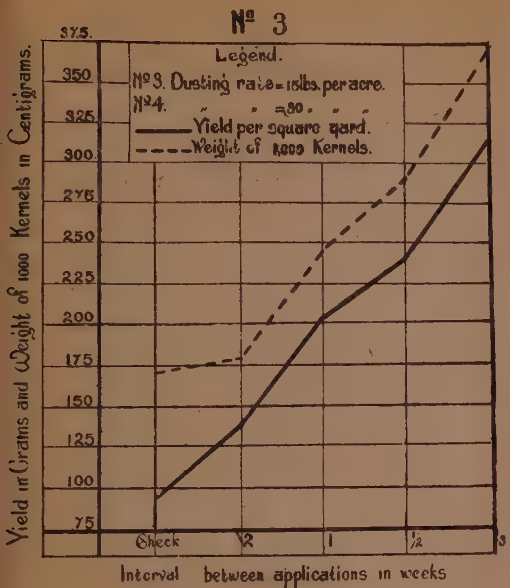
Table 2.

An Analysis of the Cost of Various Treatment in Relation to the Increased Yields resulting therefrom.

Dusting Period July 2nd to Aug. 24th, 1925 — Rate of application lbs. per acre	Frequency of application	Total number of applications	Cost of sulphur applied	Yield per acre in bushels	Canadian Government grade	Value of crop per acre	Crop value less cost of dust per acre	Increase in value per acre over value of checks
Check	0	0	$0.00	21.3	5	$23.64	$23.64	$ 0.00
15	Fortnightly	4	1.95	24.5	5	27.32	25.37	6.94
15	Weekly	8	3.90	35.7	3 Northern	45.69	41.79	23.36
15	Semi-weekly	17	8.29	43.1	2 Northern	56.46	48.17	29.74
15	Tri-weekly	24	11.70	55.1	2 Northern	72.18	60.48	42.05
Check	0	0	0	11.9	Feed	9.63	9.63	0.00
30	Fortnightly	4	3.90	20.3	5	22.53	18.63	0.21
30	Weekly	8	7.80	24.7	4	30.13	22.33	3.91
30	Semi-weekly	17	16.58	50.8	1 Northern	67.31	50.73	32.30
Check	0	0	0	19.9	5	22.01	22.01	0.00
15	Just before rains	7	3.41	42.5	3 Northern	54.40	50.99	32.56

rates of application the same general type of curve was produced. That is, there was a gradual and relatively slight reduction in the percentage infection up to a certain number of applications per week, and then a sudden marked reduction in percentage infection as the number of applications per week was still further increased. The marked reduction in percentage infection, however, begins between one and two 30-pound applications per week and between two and three 15-pound applications. If this feature is as significant as it appears, it would probably be possible to reduce the total number of applications by still further increasing the rate of application.

Plate II presents graphically the relation between the frequency of application of sulphur dust and (1) the weight of 1000 kernels of wheat from each of the various plots, and (2) the average yield of three square yards from each plot. In the case of the plots which were dusted at the rate of 15 lbs. per acre, the increased yield seems almost a function of the frequency of application. In the plots which were dusted at the rate of 30 lbs. per acre, there was a marked increase in yield of the one given two applications per week over the one receiving but one application per week. This suggests the desirability of investigating still further, the effect of increasing the rate of application.



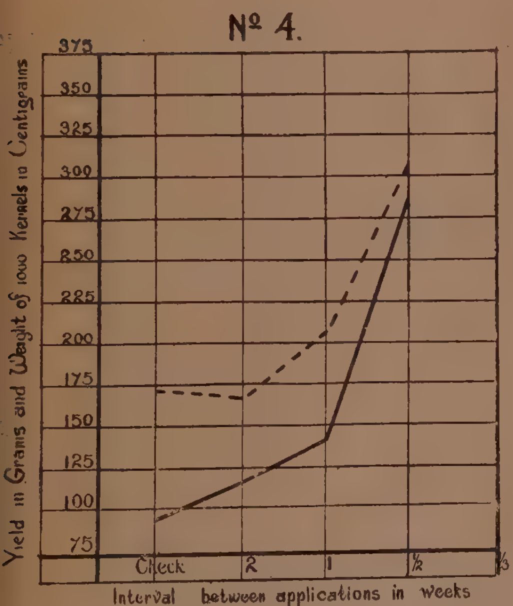


PLATE II.

No. 3—Graph showing the relation between the frequency o fapplication of sulphur dust at the rate of 15 lbs. per acre and (a) the average yield in gms. of 3 square yards from each plot and (b) the weight of 1000 kernels chosen at random from the threshed sample of each plot .

No. 4—Same as No. 3 except that rate of application of sulphur dust was 30 lbs. per acre instead of 15 lbs. per acre.

Discussion

It is quite evident that as far as local conditions this year are concerned, dusting with sulphur constituted an effective means of controlling rust when the dusting was done frequently. An analysis of the cost of material used in relation to the actual saving effected is presented in Table 2. It is evident from this table that the cost of material would not be at all prohibitive in extending this method to general farm practise. The practical difficulties and the labor costs which would be encountered in using this method on any large scale still remain to be investigated. If the results of this year can be reproduced consistently however, it is not at all beyond the bounds of possibility that some method of practical value can be developed for using sulphur dust in the control of leaf and stem rusts of wheat.

Aside from the aspects already considered, the data presented herewith are interesting also in that they permit of a fairly accurate estimation of the amount of injury actually caused to wheat by leaf and stem rusts under field conditions. If the various plots are compared with checks closest adjoining them, major variations in soil are eliminated and decrease in yield can be safely ascribed in great measure to rust. By such comparisons we note that, under field conditions, as high as 76 per cent reduction in yield occurred.

Yeast Contamination as a Source of Explosion in Chocolate Coated Candies.

DONALD BETHUNE SHUTT

Bacteriology Department, Ontario Agricultural College, Guelph, Ont.

During the past year a large manufacturer experienced considerable losses due to the cracking and leaking of chocolate candies in storage. As a result the following investigations were made to locate and remedy the cause.

Historical

Weinzirl (1) has reported a systematic investigation of this problem. He states that *B. sporogenes* is the chief cause and that yeasts may be a cause. Egg albumen was proven to be the source of *B. sporegenes*.

Process of Manufacture of the Chocolates

The chocolates were made by rolling the filler, or nougat cream, in starch or powdered sugar, dipping them in melted chocolate and setting them aside for hardening. The filler or nougat cream contained the following ingredients; corn syrup, powdered sugar, egg albumen and tap water. These were mixed according to formula and boiled for thirty minutes. The mixture was then removed from the kettle and poured into a large wooden barrel for storage purposes. Portions were removed as desired for rolling and dipping but the barrel was seldom completely emptied before the next batch was poured in. The finished chocolates were stored at 68°F. for not longer than two weeks, after which they were taken to the store and either held on the counter or kept in show cases until sold. The temperature of the store varied betueen 68°F. and 72°F. depending upon the weather.

Laboratory Examination

The chocolates submitted were all either cracked or broken, some had portions forced out as if pressure was behind them. The interior was found to be spongy with numerous small holes throughout the filler. There wa little or no odor and the taste was quit pleasant. The hydrogen ion concentration i all samples proved to be PH=5 —6.

Due to the low hydrogen ion concentratio of the interior of the broken chocolates an the presence of a greater proportion of car bohydrates than protein, yeasts were suspect ed to be the cause of the bursting.

To determine whether yeasts or bacteri were responsible the following media wer employed in the investigation:— Nutrien Agar, made according to Standard Method of Milk Analysis (A.P.H.A.), Nutrient Brot (S.A.B. Pure Culture Methods), Sabouraud Agar (Difco), Dextrose Peptone Water o the following formula; Dextrose 10 grams Peptone 1 gram, Water 100 cc. This wa placed in fermentation tubes. Imitation cho colates were also made in glass test tubes for observation purposes, by pouring in te grams of nougat cream, plugging with cotto and steaming for three successive days fo twenty minutes. After inoculation with th organisms the nougat cream was covered wit paraffin wax to a depth of half an inch.

The interior of the chocolates was firs examined. Bacteria grew on the nutrien agar cultures but fished colonies from thes failed to produce gas in the dextrose pepton water fermentation tubes at either 68°F. o 90°F. Pink and white yeasts were numerou on the Sabourauds agar cultures and fishe colonies from these produced much gas i the dextrose peptone water fermentation tube at both temperatures. Transfers from th fermentation tubes to the imitation chocolate gave rise to much gas and finally complet expulsion of the parafin plugs when incubat ed at 68°F. The time required for expul sion was twenty days at 68°F. and from fiv to eight days at 90°F. Microscopical exam ination of the fluid in the fermentation tube

d the imitation chocolates showed yeasts ly. It was later found that the pink colies mentioned above contained both pink d white yeasts and that the pink yeasts ere incapable of producing gas in dextrose.

Portions of the raw materials were examin- and plated out, but no yeasts were found. small amount of gas was produced in the rmentation tubes, but upon microscopical amination the organisms proved to be bacria. The gas was less than one per cent.

A sample taken from the kettle after the gredients had been boiled for half an hour oved to be sterile on all media. Apparent- boiling for half an hour destroyed the iginal organisms in the raw material.

Three samples were taken from different tches from the wooden barrel and portions ere plated and inoculated into fermentation bes and imitation chocolates. All three tches produced abundant gas in the ferentation tubes, taking eight days at 68°F. d two days at 90°F. The gas proved to be $)_2$ = 99.5 per cent, H_2 = .5 per cent. The itation chocolates exploded within ten days 90°F. and twenty-five days at 68°F. The ntents when heated gave off an odor of cohol. Microscopical examination showed ast only.

Several poured plates of Sabourauds agar ere exposed in the factory for five minute tervals. A few yeast and mould colonies veloped. Less than ten per plate.

Conclusions

The raw material entering into the comsition of the filler for the chocolate candies was contaminated with micro-organisms, but the necessary boiling in the ketle destroyed them. Contamination of the filler was brought about by an unclean wooden barrel used for storage purposes. This barrel was seldom thoroughly cleaned out between batches. Substitution of containers for the filler of a size large enough for only one batch at a time and capable of being thoroughly washed and sterilized between use prevented further outbreaks.

Summary

1. Explosion or bursting of chocolates was found to be due to the growth and development of yeasts.

2. The source of the yeasts was found to be a wooden barrel, which was used to hold excess filler until required for dipping.

3. Further outbreaks were controlled by installing vessels capable of being cleaned and sterilized between batches.

Acknowledgements

The writer desires to acknowledge the assistance of Mr. F. Pugh, scientific expert for the manufacturer concerned, in placing much information at his disposal.

References

(1) The Cause of Explosion in Chocolate Candies, John Weinzirl, Jour. of Bact. Vol. VII, No. 6, 1922, p. 599.

B. T. BARN BOOK

Beatty Brothers, Ltd., of Fergus, Ontario, to be congratulated on the latest edition their B. T. Barn Book, which we have ently received. It is complete in every se, well illustrated, contains detailed specifications of barn and stable equipment, and numerous blue prints. There are 350 pages.

Every member of the C.S.T.A. who is farming or who gives advice to farmers should have a copy of this book and may obtain one, without charge, by writing to Beatty Brothers, Ltd., Fergus, Ont.

The Ontario Agricultural College in its Relation to Agricultural Education, Agricultural Experimental Work and Agricultural Research.

G. C. CREELMAN

Beamsville, Ont.

On August 12, 1869, John Carling, Commissioner of Agriculture for Ontario, wrote to the Reverend W. F. Clarke, Editor of the "Ontario Farmer", commissioning him to visit the leading Agricultural Colleges of the United States, and to report thereon to the Department; such report to embrace, among others, the following particulars:—"The establishment, cost and mode of sustaining such colleges; with the experimental or model farm attached; their management; the course of study pursued at them; the professorships in them; the attendance of students, the estimation in which these institutions appear to be held in the United States; their practical working; the results of their operations, so far as can be ascertained, the expense of their maintenance; and the extent to which by fees, manual labour of students, or otherwise, they are self-sustaining. You are also commissioned to visit the United States Department of Agriculture at Washington, and ascertain by what methods it aims to promote the farming interests. On your return you will, at your earliest convenience, embody the results of your observations in a report to this Department; and also submit an economical and practical scheme for the establishment of an Agricultural College in this Province. You will also furnish this Department with any suggestions your tour may enable you to make whereby its serviceableness to the agriculture of this Province may be enhanced".

Mr. Clarke's Report

On June 8, 1870, Mr. Clarke made his report, in which he described his visit to several of the more prominent Agricultural Colleges in the United States; from among these he selected two, which he described as being "exemplary, if not model, in their character". These two were the Agricultural College of Massachusetts, situated at Amherst, and the Agricultural College of Michigan, located at Lansing.

Colleges in the United States

In 1862 the United States, by an Act of Congress, made munificent land grants to several States in the Union, for the permanent endowment of Agricultural Colleges. The purpose of the donation, as stated by the originator of the Bill, was as follows:—"To establish at least one college in every State, upon a sure and perpetual foundation, acceptable to all, but especially to the sons of toil; where all the needful sciences for the practical avocations of life shall be taught; where neither the higher graces of classical studies, nor that military drill our country now so highly appreciates will be ignored, and where Agriculture, the foundation of all present and future prosperity, may look for troops of earnest friends, studying its familiar and recondite economies, and at last elevating it to that higher level, where it may fearlessly invite comparison with the most advanced standards of the world". Under this Act each State became entitled to a quantity of public land, equal to 30,000 acres for each of its Senators and representatives in Congress, under the census of 1860. It was provided that this land should be sold to the best advantage, under the supervision of each State, and the proceeds invested as a perpetual endowment in safe stocks, yielding at least 5% per annum. The College at Amherst owed its existence to this national land grant. That of Michigan was already in prosperous operation when the grant was made, but, of course, received considerable impetus from this Legislation.

Massachusetts

Massachusetts secured 360,000 acres, and the Governor of the State wanted to turn it

ver to Harvard University, but, Mr. Clarke ays in his report, "In spite of the conceded dvantages of existing Professorships in ranches of study requiring to be taught in course of Agriculture and of means of instruction and illustration in large libraries and costly apparatus, the Massachusetts Legslature decided to establish a separate institution as an Agriculture College". It will hus be seen that at the formative period of stablishing Agricultural Colleges the question of incorporation with the State University as against a distinct and separate location, was subject to discussion. The course vas laid out for four years, and a large mount of the students' time was devoted to manual labor, for which they were paid 12½c n hour. Mr. Clarke says, "the last report of the Trustees of the College holds it out s an inducement to students that, with the manual labour facilities provided, a young man with good talents, who is healthy and willing to work can obtain a superior eduation at this institution for $100 per annum, n addition to what he can earn on the premses. Most of the Agricultural Societies in he State assumed the responsibility of payng the term bill of one or more students, the mount per annum of each being $54.00. hese Agricultural Society Scholarships were ffered for competition, and the candidates assing the most creditable examination beame entitled to them. By this means, and he manual labour arrangement, a Scholarhip student is at an outlay of not more than 50.00 per annum". It speaks well for the eputation of this College that it has been lled with students ever since its opening in ctober, 1867, and that they have been chiefly armers' sons who have been in attendance. early all have been full course students. his College is considered to have been reharkably successful.

Mr. Clarke reports, "that the total cost of aintenance, inclusive of the farm, is about 20,000 per annum, of which term bills, farm roduce, etc.; pay about one-half, leaving bout $10,000 per annum to be provided for ut of the endowment fund".

Michigan

Of the Michigan Agricultural College Mr. larke has this to say: "I proceed now to give a brief account of the Michigan Agricultural College, and without at all disparging the institution already described, or any other, I am constrained to award the palm of superiority to it for the practical good sense, wise economy, determined energy, and encouraging success, which have characterized its arrangements and history. In many respects it is especially worthy of being made a study by those who are anxious to establish on a sound basis, and without extravagant outlay, an Agricultural College in a new and rising country".

The Institution was founded in 1855, when the Legislature made an appropriation of $40,000 for the establishment of a State Agricultural School. From the beginning the Institution seems to have been prosperous, and in 1870, when Mr. Clarke visited it, there were eighty-two students in attendance, representing twenty-six counties of the State, sixty-two being sons of farmers. By actual legislative enactment it was required that three hours of each day should be devoted by every student to labour upon the farm, and no one was exempt, except for physical disability. In commenting upon this, Mr. Clarke says, "This requirement of labour is made, not only because it is remunerative to the students, but because it is educational, and calculated, at a period when tastes and habits are formed, to induce love of work and sympathy with the working classes. It is found that, as a matter of fact, students who pursue a College course without labour rarely engage in industrial pursuits, and it has been urged, as an objection against Agricultural Colleges, that they will tend to divert their pupils from the actual work-a-day life of the farm to professional pursuits. Special pains are, therefore, taken at the Michigan Agricultural College to render labour honourable and attractive. The officers of the Institute work with the students, or personally superintend their work. After a thorough trial of its merits, the Trustees and Faculty of the Institution cling very tenaciously to the manual labour feature of the College, and regard it as intimately connected with its prosperity and usefulness". Mr. Clarke reports that at some other institutions he had visited, student labour had proved a failure. The reasons for the success of student labour

at Michigan College are given as follows:—"That requiring all students, without exception, to labour effectually, prevents the springing up of caste among them, while participation in actual work by officers of the Institution themselves does much to make labor appear respectable and inviting to the young man". Mr. Clarke adds, "That there is much force in these considerations no thoughtful mind can deny".

The requirements for admission at that time were as follows:—

1. That all applicants must be at least fifteen years of age.
2. That students must pass a satisfactory examination in Arithmetic, Geography, Grammar, Reading, Spelling and Penmanship.

The law also says, "The College shall be a high seminary of learning, in which the graduate of the common school can commence, pursue and finish a course of study".

The chief objects contemplated by the College were:—

1. To impart a knowledge of Science, and its application to the arts of life. Especially are those sciences taught which relate to Agriculture and kindred arts, such as Chemistry, Botany, Zoology and Animal Physiology.
2. To prosecute experiments for the promotion of Agriculture.
3. To afford the means of a general education to the farming classes.

Tuition was free, board $3.25 a week, room rent 4.00 a year. The rooms were furnished with bedsteads and stoves. The students supplied the rest. The cost of the Institution in 1870 was about $10,000 a year.

Mr. Clarke says, "There is already much pleasing evidence of the usefulness of this College, and of its high and growing appreciation by the farmers of Michigan. A good proportion of its graduates are engaged in practical Agriculture. Four of its graduates have become professors in Agricultural Colleges.

ONTARIO AGRICULTURAL COLLEGE

The farm at Guelph was purchased in 1873, and the school opened in May, 1874. H. McCandless was the first Principal, but, on account of disagreement with other officers, resigned within two months; when Mr. Ch les Roberts, a distinguished British Agric turist, was appointed in his stead. Princip Roberts had only two weeks on the job wh he took seriously ill, and was obliged to tire. He was succeeded by William Joh ston, a man highly honoured and respected everybody. Principal Johnston proved to a first class educator, administrator and d ciplinarian, and he remained as head of t school for five years.

The Scope and Purpose of the O.A.

In the first report, in 1875, Preside Johnston outlines the scope and purpose the Institution:—"Before proceeding to cord the operations and results of the pa year's work, in order to understand thoroug ly their scope and aim, it may be well to ca to remembrance the reasons which led to t establishment of this Institution, the en it is expected to secure, and the manner which it is to be employed in order to a complish those ends".

"In the first place, then, it was evident the most cursory observer that Canada d pended, and would be obliged for ma years to depend, largely, if not exclusivel on her raw produce for her national wealt And amongst the various forms of raw ma erial none were so valuable as those includ under the head of agricultural produce. T observant statesmen it was plain that t readiest manner of increasing the nation wealth was by increasing the quantity a quality of that produce. But, though plain seen, it was not so easily accomplished. Pr cedent, prejudice, and general conservati stood in the way. Though throughout t Province there was a powerful minority intelligent, enterprising and successful far ers pursuing an improved system of cult vation, yet the great majority were depen ing solely on increased acreage for increas returns. This could not last, and, looki to the near future, the various means of pr ducing increased returns from the same acr age were earnestly discussed by thoughtf men. There were two main difficulties the way, arising from two different class of agriculturists. The one class, like t earlier settlers, pursued no system, follow

no fixed rotation, placed in and took out what the land, rich or impoverished, afforded them and, unaccustomed to consecutive thinking, blamed the seasons or Providence for the smaller yearly returns. The other class were thoughtful, intelligent farmers, well able to trace the relation of cause and effect in their action and reaction on soil and crop; well read—knowing that in other countries land not half so valuable was yielding double returns by a system of improved farming. The means of improvement they knew, but how to procure them, or if procured adapt them to this country, was the question. Improved seeds, improved stock, improved methods of cultivation — all were wanted. But these involved climatic trial, trial involved failures, failure involved loss of capital, and the capital to lose few in this new land possessed. Here, if anywhere, even on the most rigid grounds of political economy, was a sphere for indirect governmental action. On the one hand was the certainty of diminished returns; on the other the possibility of increased receipts. To make the certainty an impossibility, and to make the possibility a certainty, the government took indirect action. They determined, to a certain extent, to meet the wants of the second class; and if not the desire, at least the results of the action of the first. They determined that with regard to the latter it should not be the fault of their rulers if the sons were not better producers than their fathers; and with regard to the farmer, that the loss incident on experiments that were to benefit the country at large should be borne by all that were benefited; and that the intelligence, enterprise and energy of the producer should be spent on that which had already been proved successful. Those were the reasons for the establishment of such an Institution as this".

"Its objects, as will be readily seen from the foregoing statement, must be twofold. It must, in the first place, teach to the succeeding, if not the present, generation the most improved methods of cultivation — in one word, "train young men in the science and art of improved husbandry"; and in the second, it must conduct experiments and publish the results".

The First Five Years

At the end of the first five year period the President of the College resigned. 238 young men had passed through his hands and most of them were engaged in practical farming. In his final report to the Government he outlines the future work, the future progress and the future relations to the Agricultural College:— "But the majority of the Institution has not been reached; the real work of life lies ever onward. That work is to lead the van in all the education, literary and technical, of the future producers from the soil; to assist them in training their minds, beautifying their homes, raising their social status, ennobling their profession and enriching their country by becoming so thoroughly qualified in their business as greatly to increase the amount of its agricultural produce. It is so to experiment on the different varieties of seeds, plants, trees, shrubs, soils, manures and modes of cultivation; the various breeds and crosses of cattle, sheep, swine and poultry; that to all the farmers of the Province the best of their raw materials that the world can produce, and the latest modes of handling them that it uses, may always be placed within their reach, that Ontario may ever occupy a prominent place in the forefront of the march of agricultural improvement And, just as in the life of the individual, continual self-culture is absolutely necessary to success, so in the life of the Institution, in order to accomplish those ends, must there be steady and continued internal progress. The subjects and course of study must be lengthened, widened and specialized, the staff increased by appointment of directors to subdivided departments; the farm-steadings reorganized and largely rebuilt; the stock kept up; the gardens, orchards, nurseries, grounds and garden buildings so perfected as to make a complete horticultural department; shops erected, and machinery, implements, tools and appliances increased, to ensure the perfection of the mechanical one; *and the world put under tribute to make the experimental station a success.* And its external relations with all the agricultural and educational institutions of the Province must be closer, clearer and better defined. It should be the head of a series of self-sustaining agricultural schools, established in scores of

districts, drawing their supply from the public schools, whose higher courses of study should contain an agricultural course; a great portion of its subjects should be placed on the curriculum of our high and collegiate schools, and the results of the whole determined by the examinations of our national University. And, on the other hand, in order to ensure the suitability of its experiments, it should be in constant communication with every organized body of farmers, have an army of correspondents, and hundreds of voluntary experimentalists throughout the whole Province".

Teaching and Experiments for Fifty Years

For fifty years the College has stuck very closely to this text "teaching and experiments". At times it has also found it necessary to send the staff out to farmer's meetings, in order to advertise the Institution, and for a number of years the month of January was devoted to this work in a systematic way, each member of the staff being delegated to a whole series of meetings throughout the Province. This helped very materially to make the Institution better known, and, when followed up by farmer's excursions to the College in June, it soon became generally felt that the Institution might be of real service to the practical farmer on his own farm.

Teaching Science is Difficult

It has always been uphill work trying to persuade legislators, school trustees and other people responsible for the expenses of education that the sciences cannot be properly taught to students in large classes by lecturing, nor by text books alone. Experimental work, of course, calls for close application, on scientific lines, to specific problems, and teaching, or public lecturing, or any other diversion, always handicaps the work of the experimenter. There is no doubt in my mind that a large part of agricultural experimental work in nearly all of our institutions has been handicapped, and results materially interfered with, by the necessity of the experimenter leaving his work to teach regular classes and going on the public platform to explain what he is trying to do.

From the very beginning however, the staf has been entirely inadequate to accomplis the work in hand. Ten years after the College had started, long after the grounds ha all been laid out, walks and drives finished fields drained, a regular rotation of crop inaugurated, good flocks and herds establish ed and 130 students in attendance, one ma was teaching all of the Botany, Geology Entomology, Bacteriology, Chemistry, Zoology, Horticulture, Physiology, Meteorology and English Literature. The only laboratory on the place was 8 by 14 feet, and in this all the sciences were taught. The total staff consisted of five men, and all of them had other duties besides teaching.

At Guelph, the work as outlined by Dr. Johnston in 1879, has been pretty well carried out. Teaching of students, conducting experiments, publishing bulletins and addressing farmer's meetings have been the principal business of the staff, and I have no hesitation in saying that such work has all been well done through all the years that have intervened since. The staff has always been known as a hard-working, conscientious body, few, if any, holidays were indulged in, teaching through the long sessions was continuous and hard, with large classes, interfered with constantly by public engagements, while the summer season, which to other institutions meant holidays, to our staff but gave freedom from class work to indulge in experimental activities.

Research

You may be wondering what all this has got to do with the subject of 'research' at the Agricultural College—only this, *that the Institution was not intended to do research work, that the Institution has never been sufficiently manned or equipped to do research work, that the course was never intended, and has never been modified, to educate research workers, that Ontario looked to the United States and Great Britain to conduct our research for us, and had tried to adapt their results to our conditions.* When the Institution was established, weeds were not a serious menace, the potatoe bug, and other insect pests, were practically unknown. I never heard the word "Bacteria" mentioned until I was in my third year. The San

sé Scale had never been heard of, the Sow iistle was undiscovered, plant diseases ere not considered serious and spraying d not yet been found necessary in the rden or orchard; in other words, research Agriculture was never considered at all. ow we have come to a new era—the poultry-an, the live stock breeder, the grain farmer, e dairyman, the man growing Flax or Cab-ges or Celery or Potatoes or Onions or bacco or Corn has his blight or Bacterial sease or insect enemy to contend with, of iich he knows nothing whatever, and the ly place where the life history can be work-out and the germs isolated is in a scien-ic laboratory, with a scientific man on e job.

It is a remarkable fact, that the University Toronto, soon after it got its Medical Re-arch Laboratory established, discovered a re for Diabetes. Because of Research work Medical Laboratories, we no longer fear phtheria, Small Pox, Scarlet Fever, and e other scourges that used to carry off hum-ity by the thousands. Is it not time then, at we were beginning to tackle scientifically e blights and scourges that affect our plants d animals?

Workers and Apparatus

A short time ago Sir Alfred Yarrow, England, offered to the Royal Society 00,000, to be used at the discretion of the uncil, in promoting scientific research. In iting the Society, he says "I should prefer at the money be used to aid scientific work- by adequate payment and by the supply of apparatus, or other facilities, rather than to erect costly buildings". He also says, in conclusion, "I should like to record my firm conviction that a patriotic citizen cannot give money, or leave it at his death, to better advantage than toward the development of science, upon which the industrial success of the country so largely depends".

The Rubber Growers' Association, of London, subscribed $150,000 for a new Botanical Laboratory, at the Imperial College of Science and Technology, Kensington. From this it would appear that funds might be secured for research work from individuals as well as from Governments.

Guelph Not Equipped

In conclusion I simply want to say, that the Agricultural College, at Guelph, has done well the work for which it was established, that it has given a good practical education to thousands of boys, that, by its experimental work, it has materially improved the field crops and flocks and herds of the Province, *but in pure research work it has never been equipped or manned for business*, and it is a question whether new research laboratories, which might be established in this Province, could do their best work connected with the Guelph College or entirely separate from an institution doing teaching and experimental field work. I can think of no reason now why we should waste time discussing the advantages or disadvantages of research laboratories. We ought to be building them, and training men to work in them at the present time.

Some Phases of Agricultural Policy for British Columbia.*

F. M. CLEMENT

Dean of the Faculty of Agriculture, University of British Columbia.

It is of much interest to all workers in agriculture and to all citizens interested in agriculture to know that an honest endeavour is being made to work to definite plan and policy in the development of the agricultural industry of this Province.

The crying need of industry today is that of purchasing power among the consumers of the various articles of commerce, and the crying need of agriculture today is increased or extended markets to take care of the ever increasing supplies of farm produce. Lumbering is the major primary industry of this Province, with agriculture a close second. Agriculture is rapidly gaining on the premier industry. It is possibly not too much to say that a few years hence agriculture will be the leading industry. But the problem from the point of view of Provincial development is not a question of which industry is first or second or third, but rather a question of development of the three great industries that never compete, but always complement and supplement each other. Each primary industry with its secondary phase, manufacturing, provides a market with high purchasing power for the other industries. There is an oversupply of produce only when one industry is developed out of all proportion to other industries. If purchasing power is to be improved they must be developed hand in hand.

Many of us will recall from actual experience or from the tales of our parents and grandparents, the pictures of life and living as they existed a half century or more ago. They were the days of the logging bees and the paring bees; the days of the travelling shoemaker and the homespuns. They were the days previous to the movement in large numbers from the farms to the urban centres; a movement very much accelerated in recent years. They were the days when most farmers maintained a flock of sheep from which was clipped the wool to make the homespu They were the days of the home curing pork, the home manufacture of butter a cheese. The farms and communities w largely self-sufficing; they bought little a sold little except through the general sto the farmers and the communities were r according to the bounty of the harvest. Fo and clothes were to a large degree provic at home. The community centres were thr ing. The rural churches and schools w filled to over-flowing.

But economic conditions have changed a with them a marked change has been wroug in religious and social conditions in country. For the moment, however, we interested primarily in the economic chang Today the boots and shoes are made in la industrial centres; the factory woolens ha taken the place of the homespuns; the but and cheese are made largely in the local f tories, or in the case of butter by the "c tralizer" in the distant city, and the la abattoirs have taken the place of the ho slaughterings and the curings of pork. F merly a farmer produced primarily for family and a local trade; part of the life a soul of the worker went into each commod Today production is an impersonal thi The farmer is producing for a market usua some distance away, and for a consum whom he does not know. Production changed from the personal to the imperson and from the local aspect to the national international aspect. Today a farmer s for money and buys for money; he exchan the products of the soil for the products the factory; he is doing business in a la way.

We might well stop to ask at this po if the exchange ratio between farm produ

* Broadcasted as one of a series of lectures Agriculture by the "Daily Province", Vanc ver, B.C.

nd manufactured goods is fair and equitble. It cannot be said that this ratio has lways been equitable. For a period during ne war the farmer had a distinct advantage nd his dollar in exchange ratio was worth bout $1.10 in manufactured goods. On the ther hand the exchange ratio has been mainy against the farmer. In 1922 it fell lower nan 70 cents on the dollar, and for the last hirty years the farmer's dollar has been orth about 92 cents in purchasing power f manufactured goods. This is a problem hat our statesmen must face if a balance is o be reached and maintained among the inustries. Improved purchasing power on the art of the farmer today would do much to peed up the wheels of industry. We canot stand alone. The industries are interependent.

The cry today is for more population, for he settlement of our lands, for the developnent of our resources. The emphasis is eing laid on getting increased migrations to anada and to holding our native sons and aughters at home if possible. It seems to ne that the emphasis is in the wrong place. Men and women go naturally to those places where there is a chance to make a living or o improve their conditions generally. It vould seem then that emphasis should be laid n developing markets and in lowering proluction costs so that the farming business night be more profitable. Given a chance or reasonable profits in any business and he problem of increasing population will ake care of itself. People follow opporunities.

Following such a statement it is only reaonable to ask that some constructive suggesions be offered. We must face the problems s we find them today. The telegraph, the elephone, the radiophone, transcontinental ailway systems and good roads, have not nly made possible, but made imperative, the eorganization of Canadian farms. Certain rops are more suited to one district than anther. Soil and climatic conditions make it o. So much is this the case that slowly but urely we have developed districts where cerain main industries are predominant,—coton in certain areas, corn in certain areas, heese in certain areas, race horses in Kentucky, apples in one district, strawberries in another, alfalfa in another. Natural conditions are the first great factor, but coupled with this we have our transportation systems and other means of communication. So long as this is so we are bound to have districts developed where certain crops can be grown cheaper per unit cost than in other districts. This in other words means that whether we like it or not certain districts are bound to maintain where main enterprises take precedence over all other crops. Reduced freight rates will emphasize orchard development in the districts that because of soil and climatic conditions are naturally suited to apple production. Reduced rates on grain to the coast will encourage poultrymen to grow less grain and increase their fodder crops on all the high priced valley lands. Decreased express rates will encourage the small fruit men to increase their plantings in the more favourable areas and to decrease them in districts where unit cost of production is high.

This is not to be interpreted to mean that I am advocating one crop farming, but rather simply stating that main enterprises are bound to be the rule in districts where unit cost of production of that particular commodity is low. They are producing for a market, and cost of production must be at least as low as that of the nearest competitors if they are to maintain a place in the market.

Let us carry the argument a bit further. There are several wholesale prices paid for bacon on the British market today. Irish bacon stands first, Danish next, Canadian next and United States last. The better prices are paid for certain grades and qualities such as are in demand on the part of the British consumer. The important point is that it is always a question of grade and quality—backed by sufficiently quantity. Canada has not yet produced the necessary quality in large quantity even though at the present time a premium is paid for bacon hogs suitable for the manufacture of Wiltshires sides for export. Canadian trade in bacon in the British markets is scarcely holding its own. Canadian trade in butter is of marked importance, but this trade can develop only as the standard grades and

high quality are produced in large quantity at a relatively low cost per unit or per pound. The same arguments might be advanced for cattle for export, for apples and for eggs. For wheat production nature has bountifully endowed the Western Provinces; but as settlement advances, grain-growing must give way to the more refined products. No sound national economy can be based indefinitely on the exportation of grain. The refined products must come to the fore. And the production of these in quantity of uniform high grade and quality is the work of a specialist.

This statement has sometimes been questioned; but from our experience, and from farm survey studies I am convinced that the production of a No. 1 grade of apples, the production of bacon hogs, the production of the highest grade of eggs, the production of a bacteriologically clean milk or any other product of highest grade and quality is the work of man who understands his business thoroughly, who has studied it intensively and is a specialist in his particular line.

Home markets are capable of some expansion, but the great field today is the open market of Great Britain. To extend the markets there, again I repeat that the grade and quality in sufficient quantity must be such that it will sell in place of a foreign product. If such a market development is possible there need be no cause for concern with regard to the settlement of British Columbia or Canadian farms. Men and capital will flow to a profitable industry.

And how are we to improve grade and quality? All the farm studies indicate that best grade and quality come from farms that emphasize a main enterprise rather than a number of lesser enterprises. An a few words and on a basis of principle the farm organization should consist of a main enterprise, the by-products of this enterprise should be conserved, and then the main enterprise should be supplemented by such other crops as it will pay to grow or will save cash expenditure. Every farm should have one enterprise, the product of which would be of such a grade and quality that it could compete successfully in the open markets of the world. With every farmer aiming at this ideal there would be no question of successful competition in the wor markets. This is building farms to a pl or pattern to fit in with a national and inte national economy. It means less mixing; means increased profits for the farmer, an it means more business for the country.

At the present time agriculture is an ov expanded industry in so far as breadth concerned. Men by the hundreds are leavin the lands that at the present prices of far products and the present available marke are marginal and sub-marginal lands. Th movement from the land must continue f some time. On the other hand agriculture an under-expanded industry in so far as dep is concerned. The production per cow, th production per hen, the production per ac are low, and yet the figures show that th cost per unit, that is per pound butter-fat, pe egg or per bushel decrease markedly as th high production animals are used and goo cultural practices are followed. The 4,00 pound cow produces at a loss where th 6,000 pound cow may pay expenses, and th 8,000 pound cow yield a handsome profi the 120 egg hen may produce at a loss whil the 180 egg hen is a money maker; and th 15 bushel crop of wheat may be a loss whil the 25 bushel crop per acre is profitable.

It would seem that the crux of the prob lem, so far as lower cost of production concerned, is higher production per unit pe animal or per acre.

Given these two factors—lower cost o production, due to high producing units, an each farmer specialized for grade and qua iy in some particular product,—and th problem of agricultural extension land se tlement and development will take care o itself.

I give due consideration to that grea compound of tradition on farming that ha been handed down from father to son, fro generation to generation; much of it is soun practice today. I wish also to request th due consideration be given to that great co lection of experiences that are so valuabl my experiences and your experiences th make present day practices so interesting an progressive. I wish also impore that yo supplement these two factors with the fin ings of science, the exact teachings of scient fic data. If we do this we can look forwa with justifiable confidence to the agricultur development and prosperity for the future.

Malaria and Agricultural Land.

GIULIO DEL PELO PARDI

Rome, Italy

The relation betwen malaria and agricul-ıral land has always been recognised as in-isputable from earliest times up to our own mes, and even at the present day, in spite f the efforts made to establish the theory of ıe closed cycle: anopheles—man—anopheles, large number of those who have studied the ıbject remain faithful to the earlier view. urther, those who maintain the theory of ıe closed cycle cannot in the final analysis ompletely exclude the environment, and eintroduce it as the breeding ground of the nopheles, or as setting up a certain patho-ogical condition in the human subject.

This connection between malaria and the oil was, however, always merely a matter of onjecture and never in any way definitely stablished. It has certainly tended to dis-ourage the supporters of this view that what known as comprehensive betterment of the ınd (*bonifica integrale*), which in theory hould have absolutely and finally extermin-ted malaria, in many, too many indeed, ases has not been of any efficacy.

From my own investigations, observations nd experiments there would seem to be roof that not merely does this connection xist, but that it is possible to state that mal-ria, may be regarded as a something (a quid") (it is impossible to employ words regular use if misunderstanding is to be voided) which develops in the soil, in cer-ain climates, when an impermeable sub-oil and other similar conditions prevent an asy and rapid draining away of the under-round waters. Such accumulation of watei rofoundly modifies the physical constitution f the plant-bearing soil and sets up a dif-erence between the soil and the sub-soil hich is greatly accentuated in summer, when e soil dries completely, while the sub-soil emains for much longer more or less moist.

This condition of the land (which is neg-ive in respect to Agriculture), when all the her conditions, geographical, geological, ydrographical, meterological, etc., enter in, ay be accentuated or directly produced by e systems of cultivation now in force and pecially by ploughing; hence it is that the phenomenon of malaria, far from being re-lated to the want of cultivation of the land, is actually connected with its cultivation.

From my own enquiries in fact it appears that in all the countries of the world the most malarial zones (naturally provided that the other conditions, as has been said, are also present) are not these which are uncul-tivated, but those where it is carried on with most intensity that type of Agriculture which is known as scientific.

As illustration I will add that in the Argen-tine Republic the province most visited by the scourge is Tucuman where there are large cultivations of sugar cane, with thirty sugar refineries: while in the Pampas there is no malaria, although rivers stray about in it which have not enough water to reach the sea and accordingly form pools and marshes.

As regards Italy, it will be enough to re-call that in our own *Ago Romano* all the more serious outbreaks of the disease of which there are definite historical records correspond to the carrying out of measures for the intensification of Agriculture in ap-plication of laws enacted for the purpose of encouraging land improvement or reclama-tion.

Time does not allow of quoting of facts and figures but I may remark that at the pre-sent moment we have in the *Agro Romano* no slight recrudescence of the infection and we are just now in an active period of efforts for the improvement of agriculture.

Instances of localities might be quoted which were never malarial in the past and which have been this year stricken with the disease after the carrying out of some of the enactments issued for land reclamation.

Tommasi Crudeli long ago stated in a re-port read on December 7, 1879, at the *Accademia dei Lincei* as follows: "The ploughing of land reclaimed and kept un-der pasture may convert it into a focus of malarial infection as has happened this year in the case of the estates of Valchetta and Prima Porta after some extensive lands of the Cremera valley and of the Tiber valley (the waters of both river having been com-

pletely regulated) were for the first time ploughed and brought under cereal cultivation".

I am in a position to-day to affirm that Tommasi Crudeli stated a great truth and it is lamentable that his words have not been listened to. Agricultural land, when it consists of highly impermeable clay or when at no great depth there is an impermeable subsoil as is typically the case in Lazio, on ploughing in the way now prescribed by modern technique, and with the ploughs now in use, undergoes a profound deterioriation, since the modern ploughs, in the above circumstances, leave large interstices in the lower stratum of the ploughed land and an irregular sub-soil, which prevents an easy and rapid draining of the filtering waters, with resulting excess of moisture.

This deterioration besides being most harmful, as has been said, to Agriculture, as causing scanty and decreasing production of grain, also tends to produce that "*quid*", of which mention has already been made and which I identify by the name of the "biophysical malarial minimum".

It is obvious that deep mechanical cultivation will accentuate and increase the potency of the evil.

The name of malaria might accordingly be changed to that of "Malacoltura", or better, it would be enough to remove the letter "i" from the word, since by the name "malara" *mal ara* or bad plough) there would be accurately and strictly expressed that which is the true reason and essence of the evil.

The *anopheles* is not only the means by which the disease is transmitted to man as is the case also with other species of mosquito: in its organism too there is accomplished the elaboration and the passage of the "biophysical malarial minimum" to the "vital minimum", that is to say to the parasite or haematozoon of the malady by means of which the insect infects man.

It may be that the infection once produced transmits itself in certain periods and in fixed conditions directly from the man to the anopheles and vice versa, as it would not be illogical to suppose that the conditions favourable to the production of the *biophysical malarial minimum*, would contribute to forming the habitat of the species or number of species of mosquitoes who are respo sible for elaborating and spreading the infe tion.

I have for some time carried on exper ments which support these enquiries and th theory, and I should here express my livel gratitude to the Public Health Office of Rom and especially to Profs. Pecori and De Boss for having consented to carry out some ex periments in specially favourable condition and under scientific supervision, at th "Marchiafava" Sanatorium for malaria chil dren in Rome.

In the current season, as Dr. Escalar of th Health office can also testify, I have obtain ed in the garden of this Institution a pro duction of larvae of anopheles, which o course died before becoming perfect insects.

In the Sanatorium there were under car a number of children suffering from malari and it is proved that the anopheles mus absolutely exist in the place from the mom ent in which the eggs were laid from whicl the larvae burst: but there is no malari in the locality, not even isolated cases. Henc it may be said that besides anophelism with out malaria, anophelism and malaria may ex ist, without epidemic.

It is not to be thought that there is direct emergence of the pathogenic germ from the earth and an entry of these into th human blood or into the anopheles, nor eve less is there any more general hypothesis o a mutation or transformation taking place i the soil of organismes into plasmodes o malaria in any one of the forms in whicl they appear in the malady. It is a questio of an entirely new conception based on nev theories of the composition of matter an the secret laws which regulate the phenomen of matter and of life.

I affirm here in the most absolute and pre cise way that the scourge of malaria may b completely and finally exterminated in mucl less time than at present is dreamt of an with difficulties and expense infinitely les that are now thought inevitable; and if scien tists will press forward in the way which have opened and will make the experiment I can indicate, it will in the end be possibl to conquer this terrible enemy of humanit and of Agriculture, an enemy on that accoun of the World Peace.

Rome, October 1925.

La Revue Agronomique Canadienne

RÉDACTEUR—H. M. NAGANT

De l'Enseignment Agricole Elémentaire.*

FR. MARCEL EUSEBE

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Dans les considérations qui suivent, nous oudrions exposer quelques idées, développer uelques directives en vue de mettre en lumère quelques aspects trop négligés de l'eneignement agricole élémentaire, tel qu'on le onne dans les écoles et les sections agrioles primaires et de celui qui est répandu ar les conférences, les périodiques et les raités de vulgarisation.

Cet enseignement s'adresse à la majeure artie des exploitants et des travailleurs du ol et à leurs enfants, classe sociale éminemnent intéressante, puisqu'elle constitue la ase la plus ferme de notre stabilité nationle et qu'elle est un des agents les plus imortants, sinon le premier de la richesse et u bien-être du pays.

Chez le cultivateur, le bon sens est tradionnellement robuste; mais son instruction st par trop rudimentaire, et il s'enlise dans routine. Il lui faut un enseignement, mais quel? Les théories scientifiques sont hors e sa vision; pour les lui faire saisir, il faut s abaisser et les concrétiser dans des faits alpables et exprimer leur valeur productive n monnaie sonnante. C'est là un langage u'il comprend, et en ceci il ne diffère guère u reste de l'humanité.

Ce préambule insinue déjà le genre d'idées ue nous voulons développer et sans plus rder, disons que pour donner de l'efficacité l'enseignement agricole élémentaire il imorte avant tout de le dàpouiller de son habit de ses allures mystérieuses de laboratoire cientifique et de le faire évoluer dans le omaine pratique et économique familier au cultivateur. Pour préciser nos idées nous développerons quatre caractères qui devraient à notre avis marquer cet enseignement et nous montrerons, par le fait même, ce qui nous parait être les défauts dans les programmes et les méthodes actuels.

PREMIER CARACTERE: *Le programme de l'enseignement agricole élémentaire ne devrait pas être un décalque ni un extrait du programme des écoles agricoles supérieures.*

Ce premier caractère convient spécialement à l'enseignement didactique donné dans les écoles; mais il peut aussi s'appliquer aux conférences et aux articles de vulgarisation.

Examinons un instant le programme d'agriculture qui devrait semble-t-il être non seulement le plus élémentaire, mais en outre le plus conforme aux règles d'une saine pédagogie: le programme de nos écoles primaires.

Si invraisemblable que la chose paraisse, le programme d'agriculture des écoles prim-

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* Nous publions aujourd'hui un article sur l'enseignement agricole vulgarisé qu'a bien voulu nous fournir monsieur M. Bertrand, professeur d'agriculture à l'Ecole Normale de Malonne, Belgique.

Quoique émises dans un autre pays, les considérations que renferme ce travail peuvent s'appliquer intégralement à la province de Québec, et cela d'abord parce que la mentalité de l'enfant ou du cultivateur est, sauf quelques points de détail sans importance, la même dans tous les pays, ensuite parce que l'auteur possède une grande expérience de l'enseignement agricole moyen et élémentaire. Aussi pensons nous que cet article sera lu avec intérêt par tous les agronomes qui s'occupent du problème de l'extension de l'enseignement agricole.

aires, qui s'adresse à des enfants de 10 à 14 ans, n'est qu'une énumération de titres de leçons, analogues, identiques pour un grand nombre aux titres qui figurent, à côté de noms de spécialistes dans les programmes des cours d'agronomie de notre enseignement supérieur. Sans doute on a fait une sélection dans les titres; sans doute, on en commente quelques-uns par le correctif "Notions très élémentaires "Cela n'empêche que c'est la Botanique, l'Agronomie, l'Elevage, etc., qu'il faut enseigner à ces enfants. C'est-à-dire que, au mépris des règles les plus fondamentales de la logique et de la didactique, on commence l'enseignement agricole par des abstractions et des généralisations; c'est-à-dire que négligeant tout ce qui frappe les sens de l'enfant, tout ce qui provoque sa curiosité, toute ce qui l'incite à faire usage de ses propres moyens d'investigation, on pénètre d'emblée dans l'intime de la plante et de l'animal, on décrit des fonctions cachées, des mécanismes obscurs indéchiffrables souvent au regard du savant lui même.

Conséquences: l'enseignement trop général est erroné; trop sommaire il est incompris et insipide; l'enfant n'y prend aucun goût; jamais il ne lui viendra à l'esprit l'idée de le vérifier. Et si par hasard quelque phénomène lui parait conredire les affirmations de l'école, ce n'est pas l'école qu'il accusera; ce n'est pas non plus son observation personnelle. Il se produira en sa personnalité une sorte de dédoublement: ses yeux et sa raison percevront le langage infaillible de la nature, mais ses lèvres répèteront les formules ...jusqu'à ce qu'un jour un heureux hasard l'amène à réfléchir et à parler sensément; tant est profonde la déformation intellectuelle qu'une telle méthode produit chez les jeunes élèves, elle tue la réflexion; elle incruste dans les esprits une confiance absolue dans les affirmations les moins controlées, du moment qu'elles portent une estampille officielle et elle y engendre l'habitude de généraliser sans analyse préalable, et d'affirmer à propos de tout sur les moindres apparences, les principes les plus absolus et les plus faux.

Quel remède préconiser? Un Programme Concret. En mathématiques, domaine abstrait et théorique par excellence, on commence par faire résoudre mécaniquement les opérations fondamentales, puis on enseig graduellement la théorie.

L'élève pratique l'addition, la soustra tion, la multiplication et la division des nom bres entiers, décimaux et fractionnaires avai de connaître le moindre théorème sur l numération, sur les nombres premiers, su les proportions, etc.

Procédons de même en agriculture. A lieu d'enseigner "le sol" ou "les sols" d'aprè les données livresques, analysons un sol, celu du jardin de l'école, à l'aide d'une bêch Avant de donner une leçon sur la plante, dis séquons et faisons dissèquer par les élève une laitue, une plante de pois, les plant cultivées et les plantes adventives du jardi de l'école. Etudions ensuite avec les enfant les sols et les plantes de grande culture d la région. Initions leur esprit fureteur à l art si captivant d'interroger la plante et l sol et de leur ravir leurs secrets et nous au ons fait jaillir pour eux une source de scienc autrement abondante et féconde en résultat que celle qui sort en maigres filets de notr dogmatisme verbeux et des rigides formule des manuels.

DEUXIEME CARACTERE: *L'enseigne ment agricole devrait s'adapter étroitemen aux conditions régionales et même locales d sol, du climat, de la main-d'oeuvre, des dé bouchés commerciaux, etc.*

Ce nouveau caractère se réalisera de lui même si le programme est conçu objective ment comme il vient d'être dit. En étudian l'agriculture et le zootechnie de la région, o en constatera les lacunes, on reconnaîtra le perfectionnements à réaliser dans les méth odes, les améliorations à introduire dans l matériel et les réformes qui s'imposent dan tous les domaines et jusque dans de multi ples questions de détails dont l'importanc échappe au jugement routinier des cultiva teurs traditionalistes. C'est ainsi qu'on in sistera sur l'emploi de machines, sur l'adap tation des fumures, sur la conservation e l'emploi du purin, sur l'hygiène du bâtimen et sur l'hygiène du corps tant pour l'homm que pour l'animal, sur ce qu'ont de déraiso nable et parfois de dangereux certains pré jugés locaux, etc.

Il importe donc que les professeurs et le conférenciers étudient la région où ils e seignent; que les périodiques aient des co

espondants bien documentés dans les can- ons où ils sont lus, et que leur rédaction anifeste dans la mesure du possible un souci onstant de régionalisme bien entendu.

Pour réaliser ce caractère d'adaptation, le remier moyen est ici encore, la réforme es programmes; un programme objectif et oncret est le premier pas à faire. A titre ocumentaire, signalons le programme trictement régional rédigé, pour la com- nune de Céroux—Mousty, par Monsieur Al- honse Proost, Directeur Général Honoraire e l'Agriculture.

Pour le réaliser au maximum, il semble ue l'idéal serait d'obtenir le concours de raticiens instruits et experts dans l'art agri- ole. Des collaborateurs de ce genre prêcher- ient d'exemple et de parole: leur ferme bien outillée et bien organisée, leurs méthodes la hauteur du progrès, leurs cultures opul- ntes et admirées, donneraient à leurs paroles un autorité incontestée; un article de leur olume, une causerie faite par eux aux cul- ivateurs de leur région auraient une saveur renante de réalisme dont on regrette trop ouvent l'absence dans les productions des ompétences qui manient moins la charrue que la plume.

TROISIEME CARACTERE: *L'enseigne- nent agricole devrait être pratique, se baser le lus possible sur l'expérimentation agricole t être sanctionné par de nouvelles expérien- es, des concours et des expositions agricoles ocales.*

Que l'enseignement agricole doive se baser sur la pratique et viser à la pratique, nul n'en disconvient, du moins en principe. L'agriculture est une industrie; elle a ses néthodes et ses procèdès propres; rien n'est à inventer; mais on peut perfectionner les néthodes de production; on peut faire un choix plus heureux des spéculation à réali- ser, ce qui requiert des essais ou des des ex- périences.

Or, il existe dans littérature agricole un stock considérable d'expériences instituées et bien conduites dans toutes les branches de l'agriculture. Des hommes éminents y ont présidé et ils en ont fait tirer les conclusions qu'elles comportent. Combien il serait désira- ble que les professeurs, les conférenciers et les publicistes exploitent cette mine- pré cieuse et si suggestive. Leur enseignement, appuyé sur une base aussi solide n'aborderait jamais les régions de l'utopie et il acquer- rait, du même coup, un caractère positif et convaincant d'autant plus marqué que ses données seraient plus simples et plus lumin- euses; ce serait l'enseignement par les faits. Il suffit de l'avoir essayé pour être convaincu de l'intérêt qu'il inspire.

Appuyé sur l'expérimentation, l'enseigne- ment agricole réclame une sanction. Celle-ci devrait être double.

1o Sanction de vérification: par des es- sais de culture dans des champs d'expériences, par des essais d'alimentation sur des animaux domestiques, on mettra à l'épreuve les per- fectionnements et les améliorations proposées au nom du progrès et on cherchera à adapter aux conditions locales celles qui auront ré- sisté aux assauts de la critique. (Une telle sanction ne saurait être trop recommandée à l'égard de produits prônés comme merveil- leux par certaines réclames et par la propa- gande charlatanesque de nombreux chevaliers d'industrie.)

2o Sanction d'émulation: Cette sanction comporte des concours et des expositions. Les concours fonctionnent depuis longtemps pour les animaux reproducteurs et leur ef- ficacité est bien connue. Ils sont établis de- puis quelques années pour les cultures; et d'emblée ils ont stimulé le zèle et l'ingénio- sité des cultivateurs en mettant en vedette leur degré d'habileté professionnelle. Des expositions locales annuelles ou périodiques, là où elles sont possibles, constitueraient pour tous les visiteurs la plus claire et la plus persuasive des "leçons de choses" et pour les exposants un puissant stimulant dans leur marche vers le progrès et une récompense hautement appréciée, laquelle n'excluerait d'ailleurs ni les primes, ni les distinctions honorifiques. Des expositions de ce genre, éablies depuis de longues années à Céroux Mousty par Monsieur Alphonse Proost, y produisent les plus heureux effets.

La réalisation d'un tel programme exiger- ait un cycle de deux années au moins. La première année serait consacrée à une série de leçons ou d'articles de revue, formant un cours complet, sur une spécialité unique. La deuxième année amènerait le jeu des sanc- tions: champs d'expériences concours, exposi- tions.

Là où un tel système est réalisable et où il fonctionne bien, le progrès ne peut manquer de fleurir.

QUATRIEME CARACTERE: *L'enseignement agricole devrait initier le cultivateur au calcul des prix de revient et à la pratique de la comptabilité agricole.*

Savoir distinguer une fétuque d'un paturin, c'est bien; mais la science vitale c'est l'étude de l'économie agricole. Décrire la culture d'une plante, c'est bien; mais ce qu'il faut surtout enseigner c'est combien d'hommes, combien de chevaux, combien de temps il faudra pour executer cette culture, c'est l'analyse du prix de revient à la lumière des résultats. La différence entre le fermier qui réussit et celui qui ne réussit pas réside dans la manière dont est tracé le plan de travail avec un personnel donné pour l'utiliser en pleine force au bon moment (D. Hall, Direct. Génér. de l'enseignement au minist. de l'agriculture de Londres) Voilà le langage d'un business man. Ce devrait être celui de tous les exploitants du sol.

L'agriculture, comme toute industrie a pour but immédiat et principal d'enrichir le cultivateur et d'augmenter son bien être. Or il est évident que, sans un calcul aussi précis que possible du prix de revient de ses opérations et sans une comptabilité au moins rudimentaire, le cultivateur s'expose à travailler à perte, à se ruiner ou tout au moins à ne percevoir, pour des travaux pénibles et souvent répugnants, qu'un bénéfice dérisoire.

Mais une comptabilité exacte, sans cesser d'être simple, est une tâche épineuse; le calcul des prix de revient lui même n'est à la portée que des esprits familiarisés avec l'analyse. Une imitation progressive et assez longue et des modèles concrets sont ici indispensables.

C'est au professeur au conférencier, au publiciste qu'incombent et l'initiation et la présentation des modèles.

Avant tout, il faut initier le cultivateur au calcul des prix de revient. Ce point acquis, la comptabilité ne présentera plus guère de difficultés.

Si les cultivateurs éprouvent une si invincible répugnane à entreprendre une comptabilité, c'est qu'ils se buttent en ceci à de multiples obstacles. Mais il est permis de penser que les difficultés les plus insurmontables—non les plus avouées—réside dans le manque d'idées précises et de bas d'appréciation relativement à leur travaux, à de nombreux produits de leur exploitati surtout de ceux qui ne font pas habituell ment l'objet de transactions commercial L'initiation au calcul des prix de revient le apprendra l'art d'analyser et d'appréci jour par jour leurs opérations avec pré sion et méthode.

Pour y réussir, aucune leçon, aucune co férence, aucun article de revue ne se termi era sans en donner un modèle.

Supposons que les conférences ou les leçon aient pour objet la culture du froment. L prix de revient suivants seront calculés re pectivement à la fin de chaque leçon; o opère sur I acre:

1o Valeur locative de la terre;

2o Frais détaillés des labours et de pr paration du sol;

3o Part à la fumure et aux engrais com merciaux, frais d'épandage.

4o Prix des semences et frais d'ensemen cement.

5o Frais des travaux d'entretien.

6o Frais détaillés de la moisson, de ba tage de nettoyage du grain, de son transpo et éventuellement de sa conservation.

7o Frais d'assurance, d'amortissement d matériel, d'impôts etc.

A la dernière conférence, on fait le tot des dépenses et voilà le cultivateur renseign sur la somme dont son froment grève so budget.

Connaissant ensuite le rendement de la r colte et le cours du marché pour la paille pour le grain il conclura de lui-même à valeur financière de la spéculation froment.

Des calculs analogues effectués sur les a tres branches de l'activité agricole ou sur de perfectionnements proposés, tels que empl de semences sélectionnées, achat de machine agricoles etc....familiariseront peu à peu l auditeurs avec la méthode et leur faciliteron la solution des difficultés.

Ces exercices n'eussent-ils pour effets q d'habituer le cultivateur a calculer et à pr voir, ils constitueraient déjà un beau progrè Mais ils présentent un second avantage i appréciable, celui de l'initier naturellemen au mécanisme de la comptabilité agricol celle-ci en effet se réduit quant à l'essenti

calcul des prix de revient des productions gétales et animales de la ferme. Le cul- ateur qui se livre à ces calculs ne saurait der à comprendre la nécessité d'avoir une e d'ensemble sur la valeur financière de ces ltures, de ses animaux, de son outillage, de magasins, de ses travaux, de l'importance ses frais etc.....

Il voudra se rendre compte des bénéfices 'il réalise et des pertes qu'il subit non ılement dans chacune des branches de son tivité main encore dans l'ensemble. Il udra savoir d'une année à l'autre s'il pro- èsse ou s'il rétrograde et quelles en sont les uses.

Tous ces renseignements dont il sent le soin lui seront fournis par ses livres de mptabilité, avec une précision telle—notons ici—que les exigences injustifiées des agents fisc s'évanouiront d'elles même devant leur noignage.

Dès lors tout est gagné; le cultivateur, hier tomate routinier, est entré désormais dans catégorie des hommes de progrès.

Concluons en formant le voeuque l'enseigne- ent agricole élémentaire devienne de plus plus.

ojectif et concret dans ses programmes;

gionaliste dans ses tendances et dans son adaptation;

périmental dans ses méthodes;

ggestif et générateur d'émulation par ses sanctions;

qu'il s'efforce surtout d'initier les élèves et les cultivateurs au calcul des prix de revient et à la pratique de la comptabilité.

ACTIVITES DES SECTIONS

e Banquet de la Province de Québec

Nous pensons exprimer l'opinion de tous ux qui y assistèrent, en affirmant que le nquet des sections conjointes de la province Québec, de la C.S.T.A., qui a eu lieu à ontréal le vendredi 6 novembre dernier, fut franc succès et marquera époque dans existence de notre association profession- lle.

Dès sept heures, ceux qui avaient répondu l'appel lancé par le bureau de la Section de ontréal commençaient à affluer dans les lons du Cercle Universitaire, au no 361 la rue Sherbrooke est, qui ne tardèrent pas représenter bientôt une véritable ségréga- tion de techniciens agricoles ordinairement dispersés aux quatre coins de la province.

Un peu avant huit heures, soixante et quat- orze convives se pressaient autour des tables dressées sous la rotonde de la grande salle à manger, pour faire honneur au menu maigre, mais certes non maigre menu, dont des can- ards au caractère sauvage dûment authentiqué par la grenaille de plomb, dissimulaient habi- lement le côté abstinent, d'ailleurs copieuse- ment arrosé par les généreux crus rouges ou dorés de France.

Il ne sera pas étonnant non plus d'ap- prendre que le menu instructif ne le céda en rien au programme gastronomique si l'on sait que ceux qui en avaient assumé la charge étaient respectivement: le Docteur Grisdale, sous-ministre du Département de l'Agricul- ture à Ottawa, le Dr. Charron, assistant sous- ministre du même Département et monsieur Ls.-Ph. Roy, chef du Service de la Grande Culture à Québec.

Nous n'essayerons pas de donner un aperçu des substantielles conférences que nous firent ces messieurs, puisqu'il nous serait impossible de leur rendre justice dans le court espace alloué à ce bref compte rendu. C'est pour- quoi nous nous bornerons à indiquer l'ordre dans lequel se déroula le programme de cette soirée si bien remplie.

Aprés que monsieur H.M. Nagant, qui présidait la table d'honneur, eut exprimé la joie qu'éprouvait la section de Montréal de saisir l'occasion de réunir à ce banquet tant d'amis des autres sections de la province et même des provinces voisines, il souhaita la bienvenue à tous les convives et donna la par- ole au Dr. Grisdale qui commença par se féliciter de l'activité de bon aloi dont témoig- nait la C.S.T.A., pour développer ensuite ce sujet d'une si grande importance dans notre économie agricole: "La conquête des marchés étrangers."

Après cela, ce fut le tour au Dr. Charron de nous faire un brillant exposé de l'organi- sation de l'Institut International d'agriculture de Rome et de la coopération qu'y peuvent apporter les agronomes.

Monsieur Ls.-Ph. Roy clôtura la série of- ficielle des conférences par une étude des plus intéressantes sur l'organisation d'un sys- tème rationnel de culture. Pour cela, il commença par faire ressortir les résultats d'une enquête conduite dans certains comtés

de la région de Montréal, qui indiquent clairement que la vieille routine de la production du foin à l'exclusion d'un troupeau laitier y a réduit à presque rien et souvent à un résultat négatif le revenu net de la plupart des fermes. Ensuite, il établit, chiffres et documents à l'appui, comment la substitution d'un système rationnel, basé sur une rotation régulière avec production d'abondants fourrages et la formation d'un troupeau en rapport avec cette production avait accompli de véritables révolutions dans le bilan de certaines exploitations adoptées comme fermes de démonstration.

Il était onze heures et demie lorsqu'on put songer aux improvisations qui furent forcément réduites. Cependant, nous eumes encore le plaisir d'entendre monsieur Roger Charbonneau dire quelques paroles bien senties, au nom de la jeune mais vigoureuse section de Ste. Anne de la Pocatière, monsieur Narvisse Gavoi, chef du Service des agronomes de Québec qui parla au nom de ce corps, et enfin monsieur Ferdinand Larose, qui nous apporta le salut des agronomes de la province d'Ontario et proposa d'étendre les réunions des sections conjointes de la C.S.T.A. jusque dans cette province.

En finissant ce rapport, il nous reste cependant un regret à exprimer. Le départ anticipé des membres de la section du collège Macdonald, rendu nécessaire par l'heure du dernier train en partance pour Ste. Anne, n'avait pas été prévu. Ceci a réellement privé l'assemblée du plaisir d'entendre un représentant de la délégation particulièrement brillante que cette section avait envoyée au banquet.

H. M. N.

ERRATUM

Nous prions le lecteur de bien vouloir corriger le titre de notre article paru dans la livraison de septembre, lequel, n'est pas exact et contient de plus une répétition disgracieuse de termes qui s'est glissée par distraction dans notre copie définitive. Au lieu de: Les Tissus Histologiques et le Microscope Polarisant". il faut lire: LES OBSERVATIONS HISTOLOGIQUES ET LE MICROSCOPE POLARISANT.

O.C.

BIBLIOGRAPHIE

Céréales

Par C. V. Garola et P. Lavallée, cinquième édition entièrement refondue, en deux volumes. Prix 24 francs. Librairie J. B. Baillière et Fils, 19, rue Hautefeuille, Paris, 192

Nous accusons réception du premier volume de la dernière édition de cet ouvrage classique sur la culture des céréales, qui fait partie de l'encyclopédie agricole bien connue, publiée par la maison J. B. Baillière et Fils. Cette première partie comporte les principes généraux de culture des céréales, divisés en six chapitres, traitant respectivement:

1o Généralités sur la production des céréales;
2o Le climat, dans ses rapports avec la croissance des diverses espèces de céréales.
3o Le besoin d'engrais de chacune des principales céréales
4o Le sol et les engrais: Considérations sur les terres et les engrais les mieux appropriés à la culture de telle ou telle céréale.
5o La moisson: Epoque de la récolte, instruments employés, soins à donner après la coupe
6o Préparation des céréales pour la vente: Battage, nettoyage, conservation du grain et protection contre les agents de destruction.

Nous attirons spécialement l'attention sur le chapitre troisième, remarquable par ses considérations sur les besoins d'engrais des céréales. On y trouvera, notamment, des diagrammes fort intéressants qui indiquent la marche de l'absorption des différents éléments minéraux, telle qu'étudiée au cours des nombreuses expériences conduites par monsieur Garola dans diverses région de la France

Dans ces diagrammes, l'intensité relative de l'assimilation de l'azote, de l'acide phosphorique, de la potasse et de la chaux est représentée par des courbes dont les étapes sont marquées, depuis la levée, par les époques du tallage, de la floraison et de la maturité.

On sait que de cette étude, une foule de conclusions pratiques peuvent être tirées relativement aux exigences des différentes céréales comparées entre elles, et des variétés d'automne comparées à celles de printemps.

H. M. N.

Discussion on Education Policies.

On page 27 of the September issue of ientific Agriculture, the report of the ;.T.A. Committee on Educational Policies s published. President L. S. Klinck, Chair-n of the Committee, is anxious that there ill be full and frank discussion of that report, so that it may be put into final shape for the 1926 Convention.

The opinions of Mr. H. S. Arkell, Dominion Live Stock Commissioner, are published below.

Ottawa, June 15th, 1925.

ar Dr. Klinck:-

Replying to your letter of the 6th instant, beg to acknowledge draft of the report of e Committee on Educational Policies. ich you have forwarded for suggestion or ticism.

In view of the somewhat definite clash of inions in connection with the submission the report of the Committee a year ago, it d been in my mind not to make any com-nt when the draft report should be refer-l to me, as a member of the Committee, suggestion this year. It would appear, wever, that the final report now drafted es no consideration whatever to the views pressed by myself and others at the last ivention. This being the case, and, as the pposals which the report contains are so ectly at variance with my own convictions to the policies which should be followed connection with the development of agri-tural education, I felt that I must again press, in the strongest possible terms, my sent from these proposals as they stand. vould further urge that final action be not en by the Committee or by the Convention il a scheme can be devised which will bet-harmonize the views of the two schools of ught which have resulted from the study this question.

t is not may purpose to criticize at length in detail the recommendations which are bodied in this report. I should like, how-r, to set down briefly the situation which elieve will inevitably result, should they adopted.

1. Our Agricultural Colleges, so far as their degree courses are concerned, would rapidly tend to become purely academic institutions, whose professors and students in their interests and aims will be divorced from any effective contact with the practical problems of farming.

2. It would become more and more impracticable to coordinate the work of our Agricultural Colleges with the work of Provincial and Federal Departments of Agriculture, owing to the definite severing of any official or administrative connection between these bodies.

3. Our Agricultural Colleges, owing to their tendency to become purely educational institutions, would cease to function as centres where country boys are trained to take up the tasks of ordinary every-day farming, or as sources of leadership which can be depended upon to turn out men who, by training and instinct, are fitted to direct local or national issues in the development of our agricultural industries.

4. More important than all, because more vital in relation to the future of our boys and girls in the country, our Agricultural Colleges would stand to lose such support as they now possess from the farming constituency which they should serve. There is too little sympathy now between the one and the other for such a situation to be trifled with and no College, either from the standpoint of its financial requirements or as regards the bid it can make for students, can afford to break with the men and women whose needs and problems have called it into existence.

There is no intention on my part to disparage academic or scientific training. My conception, however, of the function of an Agricultural College is quite different to

that of an Arts courts in a University. It must be admitted, I think, that, if a College camouflages its own obligations to the business of farming by aping the work and functions of a University and thus weans away its students from a love for farm life and a respect for farm work, it will tragically fail in its mission. In a word, such a result would be a national disaster.

I am frankly disappointed that the report as prepared ignores, or, at least, fails to note the present critical attitude of the farming public and that it does not concern itself with the contribution which agricultural educational policy should make in relation to the practical problems of farming. Furthermore, the report is apparently indifferent to the widely recognized need for coordination of work and policy as between our Colleges and Departments of Agriculture. Under these circumstances, I feel justified in making the strongest possible protest against its adoption in its present form. The issue is so fundamentally important that I feel that it is not now a question of one school of thought triumphing over another or of one section outvoting its opponent, but it is a matter which deserves further careful constructive thought as regards the decision to be reached. I would recommend, therefore to the Committee and, through the Committee to the Convention, that a representative group of men be named to sit down together during the year, with instructions to take up this question again, in order, if possible, to devise a plan in which the views of those whose duty it has been to come to close grips with farmers and farm problems may find themselves in reasonable harmony with the principles and policies advocated and practised by those engaged in the work of agricultural education.

Yours faithfully,

(Signed) H. S. ARKELL,

Live Stock Commissioner.

A CIVIL SERVANT'S OPINION

The General Secretary,

C.S.T.A., Ottawa.

Dear Sir,—When I came to read Princ pal Cumming's contribution, in the Octob number of our magazine, to the discussic on educational policies, I first turned up th report of the Committee to give it a mo critical reading and to draw conclusions o my own. Then I found that Dr. Cummin has given substance to most of my ow thoughts. It seems to me that to apply h remarks to my own case, as one typical o non-matriculant graduates in agricultur might be helpful to the discussion.

In projecting the course of my educatio my parents had to consider how to get th greatest value for strictly limited resource I thought at the time, now I know, that the chose wisely. I feel the need of a ground ing in the higher mathematics and in lang uages, especially trigometry and Latin; i other subjects I believe the essentials of th over-passed work were fully made up. much greater handicap than the omission o these subjects was my lack of practice i competitive study. Two years made up thi lack, and my third year standing was satis factory.

In the Civil Service I have certainly foun that farm experience is of as much value a would have been matriculation. If this i true in the case of one who is working i a science subject, it is much more true o many whose positions more intimately touc farm practice. I entered college with th intention of taking only the associate cours Had I been debarred from passing on t the degree, I would not have been able t choose a position in which I would be o relatively greater usefulness than if I ha remained misfitted to the farm.

As to drawing a definite line betwee "technical" and "scientific" branches. I ca not agree that the latter, any more than th former, demand matriculation. Here know I am in danger of stepping over m

roper boundary into territory which might e left to persons of superior academic train- ıg. Yet this consideration justifies the step: Iy early interest was given to natural science, nd in childhood much of my reading was ı biological subjects. This meant that as I assed along from general agriculture into ıore specialized fields, the ground became ıore familiar. Study was no longer partly rudgery, the systematising and rounding out f formerly assimilated scraps of knowledge ecame an interesting pastime, and my lass and laboratory work became a living reality. Is it not a general rule that as one specializes in his education he instinctively gravitates toward subjects which are and have been of interest to him, and that he is wise to follow this healthy inclination? That such inclination will lead him into useful and result-producing study of his subject, in whichever class it may be? If this is so, it follows that matriculation is of equal importance or unimportance in each of these groups of subjects.

Ottawa, October 22, 1925.

S. J. NEVILLE.

Concerning the C.S.T.A.

The General Secretary regrets that, on ıccount of eye trouble at the time of going o press, he has been unable to give the ısual amount of space to notes and news conerning C.S.T.A. members. The membership ampaign is proceeding in a very satisfactory manner and the addition of the new members given on the following page brings the otal membership to over 850. The campaign will be continued through the month of December.

The eastern visit of Dean E. A. Howes, President of the C.S.T.A., has been very successful. He addressed a joint meeting of Society members and O.A.C. Alumni at Toronto on November 18th, a C.S.T.A. luncheon ıt Ottawa on November 20th and a dinner at Macdonald College on the same evening. The Secretary of the branch at Macdonald writes —"Dean Howes' visit has put more enthusiasm into this local than it has had since Lazarus came forth!"

Dean Howes left Ottawa for Edmonton on November 25th, and addressed the Manitoba local at Winnipeg en route.

1926 CONVENTION

The Sixth Annual Convention of the C.S. T.A. will be held at Ottawa on June 23 to 26 inclusive, 1926. The Canadian Seed Growers' Association will meet at Macdonald College on June 18 and 19 and at Oka on June 21 and 22. The re-union of Macdonald College graduates will be held at the College on June 28th to July 1st, inclusive.

MONTREAL BANQUET

In the French pages of this issue a full report of the banquet of Quebec members is published. English and French members joined forces on the evening of November 6th in the Montreal University Club at the first joint C.S.T.A. banquet that has yet been held in Quebec. It promises to become an annual event.

INTERNATIONAL CRITICAL TABLES

The National Research Council at Washington, D.C., has contracted for the publication of the "International Critical Tables of Numerical Data of Physics, Chemistry and Technology", in five volumes. The publication price will be $60.00 for the set, but members of scientific societies, including the C.S.T.A., are offered a pre-publication price of $35.00.

A descriptive circular, well worth reading, can be secured by writing to the National Research Council, B and 21st Streets, Washington, D.C. The pre-publication offer will expire early in 1926, but members can secure the descriptive circular in the meantime, without any obligation.

APPLICATIONS FOR MEMBERSHIP

During the month of November the following applications for membership were received:

Art, G. L. (Saskatchewan 1925 B.S.A.) Regina, Sask.
Armstrong, J. M. (Manitoba 1925, B.S.A.) Ottawa, Ont.
Besner, A. (Montreal 1923, B.S.A.) Nicolet, P.Q.
Boivin, E. (Laval 1918, B.S.A.) Piereville, P.Q.
Boyd, H. B. (Saskatchewan, 1923, B.S.A.) Regina, Sask.
Bradley, V. W. (Saskatchewan 1921, B.S.A.) Stranraer, Sask.
Bredt, P. F. (Manitoba 1914, B.S.A.) Winnipeg, Man.
Chaput, P. H. (Montreal 1924, B.S.A.) Quebec, Que.
Cooper, T. S. (Toronto 1918, B.S.A.) Markdale, Ont.
Crampton, E. W. (Connecticut 1920, B.S.; Iowa 1922, M.S.) Macdonald College, P.Q.
Edgar, J. (Saskatchewan 1925, B.S.A.) Rosthern, Sask.
Fleury, J. P. (McGill 1925, B.S.A.) Sherbrooke, P.Q.
Foster, D. C. (Manitoba 1925, B.S.A.) Lethbridge, Alta.
Gaetz, J. R. (Alberta 1922, B.S.A.) Red Deer, Alta.
Gagnon, J. Robert (Laval 1923, B.S.A.) Quebec, P.Q.
Gregory, F. W. (Toronto 1925, B.S.A.) Brantford, Ont.
Hill, F. F. (Saskatchewan 1923, B.S.A.) Ithaca, N.Y.
Horton, R. J. (Manitoba 1924, B.S.A.) Winnipeg, Man.
Jackson, A. B. (Toronto 1920, B.S.A.) St. Catharines, Ont.
Jackson, G. T. (Toronto 1925, B.S.A.) Scarboro, Ont.
Lamontagne, A. (Laval 1915, B.S.A.) La Trappe, P.Q.
Landon, G. L. (British Columbia 1923, B.S.A.) Macdonald College, P.Q.
Langlois, P. (Laval 1920, B.S.A.) Maria, P.Q.
McCulloch, J. H. (Toronto 1916, B.S.A.) Toronto, Ont.
McQuat, T. E. (McGill 1925, B.S.A.) Campbells Bay, P.Q.
Oldfield, H. G. (Toronto 1920, B.S.A.) Inglewood, Ont.
Ripley, P. O. (Toronto 1922, B.S.A.) Ottawa, Ont.
Smith, T. M., (Toronto 1924, B.S.A.) Leamington, Ont.
Stothers, I. F. (Toronto 1923, B.S.A.) Shaunavon, Sask.
Tessier, J. H. (Montreal 1925, B.S.A.) Ste Eugene de Grantham, P.Q.
Tregillus, C. A. (Toronto 1913, B.S.A.) Simcoe, Ont.
Welsh, John N. (McGill 1922, B.S.A.) Winnipeg, Man.
Woods, J. J. (B. C. 1923, B.S.A.) Agassiz, B.C.
Young, N. (Manitoba 1924, B.S.A.) Winnipeg, Man.
Younge, O. R. (Alberta 1924, B.S.A.) Wealthy, Alta.

$5.00 INITIATION FEE

Members who are assisting to enrol new members are again reminded that the opportunity to join the C.S.T.A. for $6.00 terminates on December 31st, 1925, and that thereafter an additional initiation fee of $5.00 becomes effective, making a total entrance fee of $11.00. New members are being sent all back numbers of *Scientific Agriculture* from the beginning of Volume VI, and their membership dated to September, 1926.

Immediately after the New Year, a complete alphabetical list of members will be printed and sent free to each member. Included with this list will be a preliminary announcement of the proposed C.S.T.A. Bureau of Employment and its operating policies.

Members whose fees for the current year (ending June, 1926) have not yet been paid, are asked to send them to the General Secretary during December. Present indications point to a $5.00 annual fee next year, which is equivalent to a distribution of nearly $900 among the members, and a reduction of annual fees from $10.00 to $5.00 in six years. Considering that the Society is entirely self-supporting, its financial record is encouraging. During the same years the numerical membership will be more than doubled, which is a definite indication of created and sustained interest.

Some Phases of the Inorganic Nutrition of Plants in Relation to the Soil Solution.*

1. The Growth of Plants in Artificial Culture Media.

D. R. HOAGLAND

Laboratory of Plant Nutrition, University of California.

In investigating the soil as a medium for plant growth, we must deal with the foremost problem of agricultural research, the inorganic nutrition of the plant, or in the customary phraseology, the growth of plants as related to plant foods. About ten years ago, the California Experiment Station undertook a series of investigations for the purpose of studying the soluble matter of the soil, under exceptionally controlled experimental conditions. The original investigations have ramified in numerous directions and have led to many independent researches in soil chemistry and in plant physiology, yet all of these researches bear directly on the central problem, which deals with the nature of the soil-plant chemical system. It is my main intention in these lectures to discuss some of our present views with regard to this system, and to emphasize especially its physiological aspects. These, I may venture to say, are the chief concern of those interested in agriculture. While it is my desire to stress the relations of plants to the soil, it will be essential at the outset to discuss the results obtained under the relatively simpler and more highly controlled conditions of solution culture experimentation. Although observations on the growth of plants in solution cultures (or water cultures) have been made since very early times, it is only within recent years that any sufficiently systematic and critical experiments have been initiated.

Number of Elements Essential to Plant Growth

First of all, let us consider for a moment the primary question which demands an answer. Which of the chemical elements are indispensable to plant growth? In perusing many texts on plant physiology or agricultural chemistry, one might conclude that this question had been definitely and finally settled, and that the list of essential elements comprised only Ca, Mg, K, Fe, S, P, in addition to C, H, O, N. We now have abundant evidence that such a list is not necessarily complete. Mazé (19)**, quite a number of years ago, believed that he had proved that numerous other elements were also indispensable. His conclusions were not generally accepted, but more recent researches indicate that he was correct, at least in part, in his view. McHargue (20) has presented data on manganese, the Rothamsted Station on boron (28), and Lipman and Sommer (17) in California on manganese, boron, silicon and other elements. All of the researches are still very incomplete and it remains to discover whether all types of plants require all of the elements which have been found essential for certain plants, or whether in some cases the essential nature of the elements in question might have been limited to the condition of the experiment. We know practically nothing of the function of these elements omitted from the classical list. In some cases, their effects are so disproportionate to the quantities involved that an analogy to animal vitamins is suggested.

It may be objected that such findings are entirely without practical significance for the reason that the soil moisture would never lack the very small quantities of these elements which are necessary. Such a contention would, no doubt, be true of aluminum, silicon and certain other elements, but is it certain that boron, manganese, iodine, etc. are invariably present to an extent adequate for every condition and for every crop? We are scarcely in a position to answer this question in the affirmative. It will be recalled that a similar question has been raised at Rothamsted, based

* Two lectures delivered at the Fifth Annual Convention of the Canadian Society of Technical Agriculturists, Edmonton, Alberta, June, 1925.

** A complete bibliography will be given at the end of the second lecture, which will be published in the February issue.

on the comparisons between the effects of barnyard manure and artificial fertilizers applied over a long period of years.

General Nature of Artificial Culture Solutions Suitable for Plant Growth

Turning now to a consideration of the elements required in larger quantities, we may ask what is the general nature of artificial culture solutions capable of producing satisfactory plant growth, with regard to total concentration, composition, and reaction. Sometime ago, a culture solution was prepared in our laboratories in imitation of the soil solution of a certain fertile soil (9). For this purpose, the composition of the soil solution was computed from data on water extracts of this soil. (Table 1) The artificial solution so prepared was found to be entirely satisfactory for the growth of barley plants and since then, it has also proved suitable for such diverse types of plants as wheat, cucumbers, peas, buckwheat, Bermuda grass, cotton, etc. In these cases, impurities in the salts used or derived from the glass containers, supplied the small quantities of the supplementary elements already referred to. These observations did not incline us to believe that some "best" solution could be prepared for each crop, although many experiments had been carried on in other laboratories in an effort to establish the composition of optimum solutions for the growth of different plants. Davis (5) in California repeated some of these experiments, only taking care to use a great many plants in each test so that errors of variability could be estimated by statistical methods. It was found that within the limits of error, solutions of very different composition all gave the same yields of dry matter. (Fig. 1) Now this conclusion

TABLE I.

Approximate Composition of a Culture Solution Used for Many Types of Plants.

P.P.M.

NO_3	PO_4	SO_4	K	Ca	Mg
700	117	200	190	172	52

Iron added as Iron Tartrate.

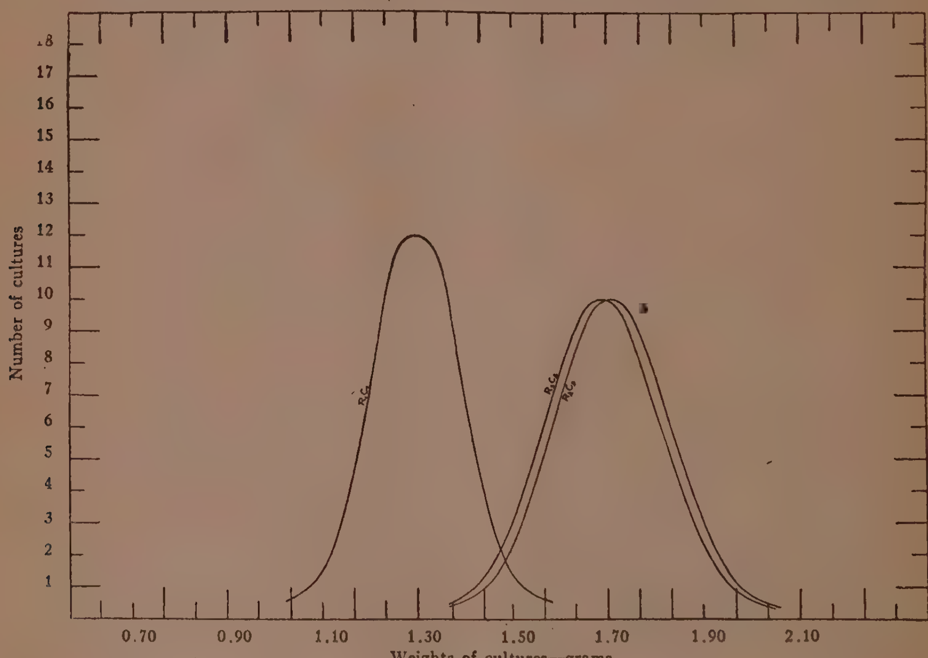

FIGURE I.

From A. R. Davis, Soil Science, Vol. XI, No. 1, 1921.

Frequency distribution of weights of tops of wheat plants grown in three solutions of different composition as follows:

	KH_2PO_4	$Ca(NO_3)_2$	$MgSO_4$
R_5C_2	.0180	.0052	.0150
R_2C_5	.0072	.0130	.0150
R_1C_1	.0036	.0026	.0400

Partial molar concentrations.

does not mean that different types of plants may not respond differently to solutions which are very deficient or unbalanced in some respect. The point to be stressed is that plants possess very considerable powers of adaptation and are under no necessity of obtaining essential elements from solutions with some definite and fixed proportion existing between the different elements present in the solution.

The adaptability of plants to different solutions extends also to variations in total concentration. The solutions may be very dilute, provided certain minimum concentrations are maintained. If comparisons be made between solutions of different concentrations, it can be shown that over any limited period of time, the percentage absorbed of the total solutes present will be much greater from a dilute solution than from a more concentrated one. If the solutions are too concentrated, inhibition of growth will, of course, result. In our experience with artificial culture solutions, satisfactory plant growth has been obtained with solutions ranging in concentration from 100 or 200 p.p.m. to 3000 or 4000 p.p.m. total salt concentration.

While solutions of very low concentration may be adequate, it will all depend upon the maintenance of the concentrations of the various essential ions above certain critical minima, notwithstanding withdrawals by the plant. The fact is often overlooked in solution culture work that absorption of ions by vigorously growing plants proceeds with great rapidity so that when very dilute solutions are employed, constant renewal or large volumes of solution may be essential. This introduces the idea of supplying power for essential elements which I hope to discuss later when speaking of soil relations.

Hydrogen Ion Concentration and Plant Growth

Another property of culture solutions which is of great interest is the hydrogen ion concentration. Within the past few years, the question has received much attention and you are no doubt familiar with the now very popular term "pH value". With artificial culture solutions it is a very easy matter to ascertain the approximate intensity of acidity or alkalinity in the solution bathing the roots of plants so that we can form some definite conception of the effects of different reactions on plant growth. Our own experiments indicate that slight acidity is not in itself injurious to any of the various types of plants tested. By slight acidity, I mean that represented by pH 5 to 7, an intensity of acidity which does not appear to be exceeded in the majority of acid soils. Alkaline solutions above pH 8 have, in general, proved to be less favorable than acid solutions, but the question of the effect of alkalinity is very complicated, chiefly because it is difficult or impossible to maintain the desired concentrations of all of the essential elements at very alkaline reactions. It may, therefore, become difficult to distinguish between direct and indirect effects of alkalinity. Reed and Haas (24-25) have demonstrated that with walnuts and citrus plants, lack of calcium causes extreme toxicity and that below pH9, the calcium concentration is of more importance than the OH ion concentration. However, it seems to be fairly certain that solutions with pH values above 9 are injurious to many or most agricultural plants, because of the high alkalinity as well as for other reasons.

Effect of Plant Growth on the Composition of the Culture Solution

In the preceding remarks, I have attempted to give an impression of the general chemical characteristics of artificial culture solutions successfully used for agricultural plants. In the descriptions of these solutions, thus far, no adequate idea has been given of the dynamic nature of culture solutions in which plants are growing. We may prepare a solution and carefully analyze it and state its composition, concentration and reaction, but after even a brief contact with the roots of an actively growing plant, the solution is no longer the one with which we started. For our purpose, the effect of the plant on the solution is a matter of great consequence, and a little time may well be devoted to this point.

Perhaps an initial inquiry might be concerned with the relation of the intake of water to the intake of solutes. A great many different opinions have been expressed with regard to this relation, but it is quite clear that plants do not ordinarily absorb a solution as such. Water and solutes may enter the plant more or less independently. If

absorption take place undisturbed, a solution may become more concentrated with respect to certain ions and more dilute with respect to others. In other words, some ions may enter the plant more rapidly than the water and others less rapidly. However, the absorption will be greatly influenced by the climatic complex because of its effect on photosynthesis and on metabolic processes in general. Therefore the same solution will have a different relation to the plant with every change in its aerial environment. (Fig. 2)).

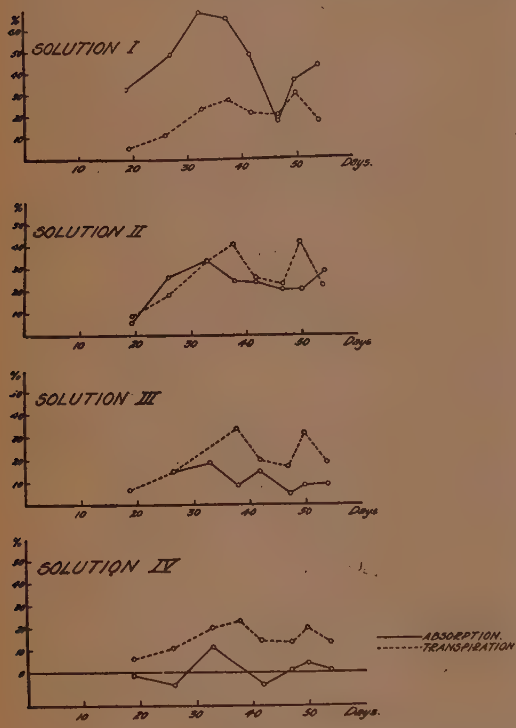

FIGURE 2
From Hoagland, Jour. Agr. Res., Vol. XVIII, No. 2, 1919.

Percentage relations of absorption of water and of solutes (as change in conductivity) with solutions of different total concentrations.

1	200 p.p.m.
2	800 "
3	2500 "
4	6000 "

Since plants absorb ions from solutions at different rates, an entire rearrangement of the equilibria in such solutions must follow, involving, in many cases, changes of hydrogen ion concentration. If a complete nutrient solution be used, such as the one already described, we shall usually find that the initia acid reaction (pH 5.0 to 6.0) is decreased ir intensity as a result of plant growth, anc that a reaction close to the neutral point i attained and perhaps maintained over a lon period. (Fig. 3) Chemical analysis of suc

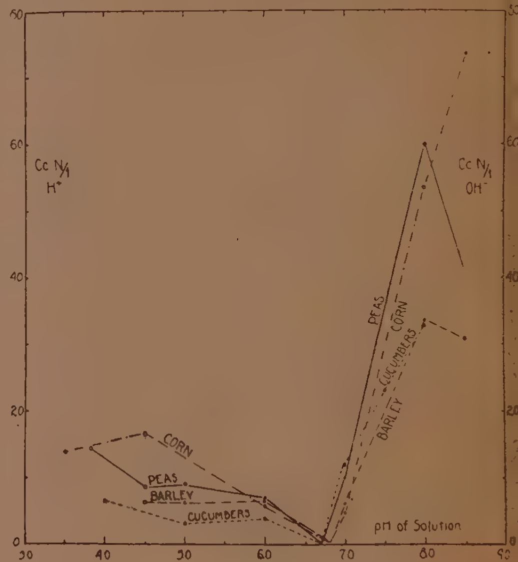

FIGURE 3.
From J. J. Theron. Univ. Calif. Publ. Agr. Sci Vol. 4, No. 14, 1924.

Amounts of acid or alkali, neutralized b 30 plants during 25 days' growth, with solution maintained at different pH values, by the frequen addition of acid or alkali to the culture solution Note marked tendency of plants to reduce alkalinity in the solution, as a result of excess absorption of cations and excretion of CO_2

solutions shows that the total equivalents o anions absorbed exceed those of cations. Th equilibrium is restored by the formation c HCO_3 ions, so that we have a system whos reaction is largely controlled by bicarbonates and the free CO_2 excreted by the roots c the plant. One of the most important features of absorption from culture solutions the rapid removal of nitrate ions and the replacement in the solution by HCO_3 ion Although this process has been more or le recognized for a long time, we are still fa from understanding the mechanism. It worth while to emphasize these changes i artificial culture solutions produced by pla growth, because there is evidence from so studies to show that very similar chang may take place in soil solutions during cro

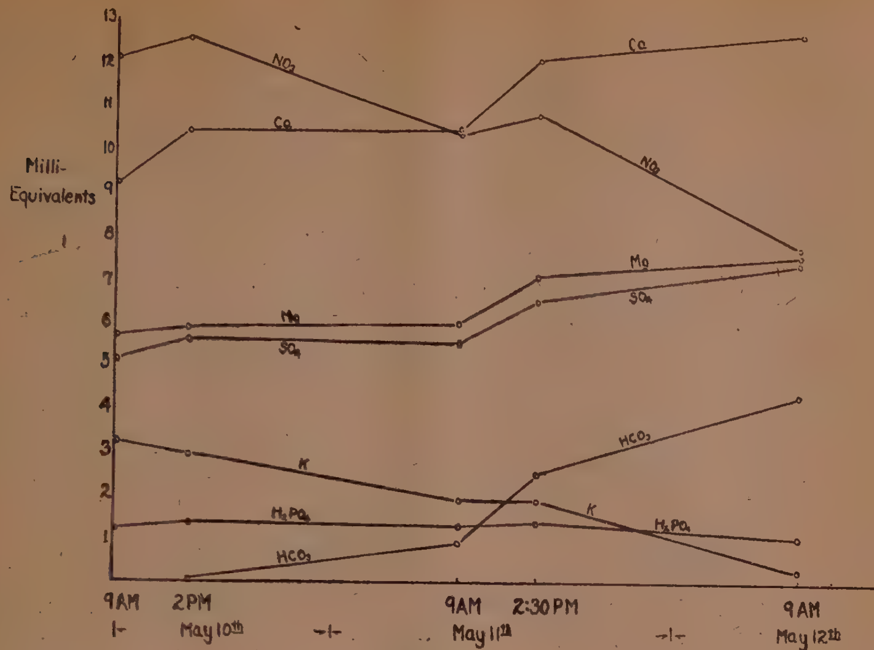

FIGURE 4

From Hoagland, Soil Science, Vol. XVI, No. 4, 1923.

Change in concentrations of ions of nutrient solution as result of absorption by barley plants, during 48 hour period.

growth and also as a result of the metabolism of certain bacteria.

If we examine in more detail the absorption of ions by cereal plants, for example, it will be noted that sulphate ions are absorbed very slowly and that Ca and Mg ions are also absorbed more slowly than K, NO_3 and PO_4 ions. (Fig. 4) It should not be supposed, however, that the rapid absorption of the last named ions is simply on the basis of the need which the plant has for them. If Br or Cl ions be present in the solution, they, too, will be absorbed with great rapidity. No one would be inclined to deny the selective action of plants in absorbing mineral elements, nor that utilization or transformations of these elements in the plant cell may sometimes influence absorption, but selective absorption is by no means a simple matter of absorbing those elements necessary for growth, with the exclusion of the non-essential elements. Such a conclusion refers, of course, to the actual intake of solutes by the plant as a whole. We cannot say what the condition is in the living protoplasm.

Composition of the Cell Sap in Relation to that of the Culture Medium

At this point, I should like to describe some experiments carried on in California and elsewhere, with a plant which has no direct agricultural interest at all, but which is beautifully adapted to illustrating certain general principles concerning the absorption of ions by plant cells. I refer to experiments made with the fresh water alga *Nitella.* (11-12) This plant has the ability to produce cells of extraordinary size, some of them attaining a length of several inches. Thus we can deal with individual cells and compare the composition of the vacuolar sap with the composition of the medium which bathes the cells. There is the further advantage that we know exactly what this medium is, without the necessity of considering soil complications. (Table 2).

The results obtained are very clear and definite in proving that the concentrations of nearly all the ions present are far greater in the cell sap than in the surrounding solution, and that the relative concentrations are

TABLE 2.

Analyses of Nitella Sap and of Pond Water.

From Hoagland and Davis, Jour. Gen. Physiol. Vol. 5, No. 5, 1923.

	Specific resistance (25°C.).	Freezing point depression	pH	K		Na		Ca		Mg		Cl		SO_4		PO_4		NO_3	
	ohms			P.P.M.	Milli-equivalent.	P.P.M.	Milli-equivalent.	P.P.M.	Milli-equivalent.	P.P.M.	Milli-equivalent.	P.P.M.	Milli-equivalent.	P.P.M.	Milli-equivalent.	P.P.M.	Milli-equivalent.	P.P.M.	Milli-equivalent.
Sap from largest cells (from pond) ..	82.3	0.465°C.	5.2	2,120	54.3	230	10.0	410	20.5	430	35.4	3,220	90.7	800	16.7	350	3.7	0	0†
Pond water	2,050	0.018°C.	7.2–9.4	*	—	5	0.2	31	1.6	41	3.4	32	0.9	31	0.7	0.4	0.004	34	0.5
Factor of concentration	25	26	—	—	—	46		13		10		100		26		870			

* Not determinable on sample of 200 c.c.

† No test with diphenylamine.

far different in the two solutions. Now such a distribution of chemical elements cannot be explained on the assumption that the elements in the cell sap are bound in some organic combination, thus accounting for the concentration within the cell. The conductivity of the sap is approximately 25 times greater than that of the outside solution, and, moreover, there is only a small amount of organic matter present in the sap. It is apparent that absorption may take place against a concentration gradient and this must mean that the process is one in which the cell plays an active, not a passive role. An expenditure of energy must occur by some mechanism which we do not understand. We have studied the effects of light and temperature on the absorption of certain ions and have found that the temperature coefficient of absorption is comparable with that of a chemical reaction rather than that of a diffusion process. It also appears that any extensive absorption of ions is conditioned on the illumination of the cells, which suggests that the energy of light, whether directly or indirectly, makes possible the concentration of solutes in the sap.

The hydrogen ion concentrations are of special interest. The sap of the *Nitella* cells preserves a constant pH value within the limits of error of the experiment, although the outside solution may have its reaction varied over a range of several magnitudes of pH values. If for any reason, the reaction of the sap is materially changed, injury follows very rapidly.

While it is not possible to investigate conditions, in higher plants so easily as in *Nitella*, the data available indicate that an entirely analogous situation exists in the former. In the first place, a very large proportion of the inorganic elements in ordinary agricultural plants is in water-soluble form. The sap expressed from the leaves of such plants will usually have a conductivity equal to, or greater than, that of a tenth molar salt solution. Potassium in all the plants which have been examined seems to be present almost entirely in water soluble and probably ionized form. It is true that in certain plants, an important percentage of calcium and magnesium may occur in water insoluble form. Perhaps the most striking example of this, as we have observed in our own experiments, is found in the buckwheat plant, in which practically all of the calcium is in-

oluble. Nevertheless, a general explanation of absorption cannot be based on precipitation within the plant cell. We shall find ourselves in great difficulty if we attempt to explain all the physiological processes of living cells on the basis of the application of the law of mass action. This statement is not intended to give the idea that a vitalistic explanation must be assumed. The laws of physics and chemistry will doubtless suffice if the mechanism of the energy exchanges can be worked out, but without an understanding of these energy exchanges, no complete solution of the problem is possible.

The Influence of the Phase of Growth

So far we have been considering the effects of culture solutions on plant growth without any special reference to the various phases of growth. It is important to inquire into this question. There is considerable evidence on this point from soil studies and some interesting observations have been made by Gericke (7) in California, using the solution culture method of experimentation. He found that some essential elements, phosphorus, for example, may be omitted from the culture solution entirely during the later stages of growth of wheat plants, without harmful effects, in fact, under the conditions employed, with beneficial effect. While there are certain differences between solution culture conditions and soil conditions with regard to phosphate to which I shall refer later, nevertheless the solution culture data are very suggestive. According to the investigator cited above, chief among the elements which apparently must be present in the solution throughout the entire growth cycle is calcium. It is thought that in the later stages of growth, a proper supply of this element may be especially important in connection with grain formation.

TABLE 3

From W. F. Gericke, Soil Science, Vol. XVI, No. 2, 1922.

Effect of $NaNO_3$ on the protein content of spring wheat (White Australin) when applied to different periods of growth

Number	Days after Planting* When $NaNO_3$ was Applied	Days before Harvest when $NaNO_3$ was Applied	Weight of 100 Kernels	Protein Content	Average Protein Content
	days	*days*	*gms.*	*per cent*	*per cent*
1		201	4.57	8.9	
2	At time of	201	4.27	8.6	8.9
3	planting	199	4.86	9.1	
4	17	183	5.11	9.6	
5	17	178	5.22	9.3	9.2
6	17	183	4.90	8.8	
7	33	162	5.11	11.3	
8	33	162	5.00	10.1	10.6
9	33	162	5.18	10.4	
10	48	147	5.22	10.7	
11	48	152	5.15	11.7	11.4
12	48	152	4.95	11.7	
13	72	135	4.92	13.1	
14	72	135	4.75	13.2	13.0
15	72	135	4.68	12.8	
16	110	121	4.00	14.7	
17	110	121	4.43	15.3	15.2
18	110	121	4.10	15.6	

*Date of planting was November 14, 1919.

TABLE 4.

From W. F. Gericke, Soil Science, Vol. XIV, No. 2, 1922.

Effect of $NaNO_3$ on the protein content of oats (variety Texas Red) when applied at different periods of growth.

Number	Days after Planting* When $NaNO_3$ was Applied	Days before Harvest when $NaNO_3$ was Applied	Weight of 100 Kernels	Protein Content	Average Protein Content
	days	*days*		*per cent*	*per cent*
1		197	Not	7.5	
2(Lost)	At time of		determined	...	7.5
3	planting	197		7.5	
4	19	178		7.7	
5	19	178		7.9	8.0
6	19	178		8.5	
7	33	164		7.9	
8	33	164		8.5	8.5
9	33	164		9.0	
10	48	157		9.3	
11	48	157		9.4	9.6
12	48	157		10.0	
13	69	136		9.8	
14	69	136		11.3	10.8
15	69	136		11.2	
16	90	121		12.8	
17	90	121		13.0	12.7
18	90	121		12.3	
19	108	111		18.2	
20	108	111		15.8	17.2
21	108	111		17.5	

*Date of planting was November 14, 1919.

Davidson and LeClerc (4), Gericke (6), and others, have also studied the effects of nitrogen application at various stages of growth of different varieties of wheat. It was found possible to produce great changes in the protein content of the grain by supplying nitrate relatively late in the growth cycle of the plant. By such means, a soft wheat may be converted into a hard one. (Tables 3 and 4). All the varieties tested by Gericke responded to the treatment in a similar way in general, yet the potentialities for increase of protein differed greatly with different varieties. On the basis of these results, it has been suggested that the methods of physiological analysis employing the controlled conditions of solution culture may become of great interest and value to th geneticist or plant breeder. These point cannot be pursued in this particular discus sion, but their mention will serve to cal your attention to the fact that the relatio of a plant to its culture medium is not a fixe one, but is constantly varying as the plan passes through its several phases of growth.

Absorbing Powers of Different Types of Plants

One of the questions which has long in terested investigators in the field of plan nutrition concerns the absorbing powers o different kinds of plants, more frequently re

ferred to as the "feeding powers" of plants. Do different types of plants possess specific types of absorption? It is very difficult to approach this question without first differentiating the various ideas which have been implied in discussions of this subject. Nearly all the data available have dealt with plants grown in soils where the problem presents the maximum degree of complexity, but certain experiments with solution cultures have also been carried on. Among these may be mentioned the experiments of J. D. Newton (21), who grew plants of different types in the same culture solution. Under these circumstances, he did not find that peas and barley were very different in respect to the relative equivalents of the different ions absorbed. A characteristic difference in absorption between barley and beans (Speckled Cranberry) was found under the particular experimental conditions employed (23). Further recent research has made other comparisons possible and it has been noted that buckwheat and barley, for example, display certain distinctive characteristics with regard to the rates at which they absorb different ions from the same solution. It is, however of equal importance that the actual composition of the plant is greatly influenced by the composition and concentration of the culture solution, irrespective of the type of plant employed. Probably in many cases, the alterations in the composition of the vegetative portions of the plant which can be induced by modifications in the culture solution may overshadow any specific difference between different types of plants absorbing from the same solution.

It is certain that the composition of the culture solution influences the composition of the plant, but there is no available method of predicting just how one influences the other. Culture solutions are very complex, both chemically and physiologically, and very difficult to interpret from either point of view. It may be assumed that the various elements exist primarily in ionic state and that absorption is concerned with ions, but very important effects of one ion on the absorption of another have been observed. Thus in solutions of single salts, barley plants will absorb potassium much more rapidly from the nitrate or chloride than from the sulphate. (10) The slow rate of absorption of the sulphate ion seems to retard the absorption of the associated cation. Analogous effects have been observed between cations and between anions. In this sense, one ion affects the availability or absorbability of another, but there is no evidence to support the idea that absorption is limited to specific combinations of ions.

Under soil conditions, the situation obviously is far more complex and various ideas have been involved in the expression "feeding powers" of plants. It will be desirable to attempt to enumerate some of these ideas, so that we may be clear as to the nature of the problem. We may mention the following points which have more or less formed the basis of discussions on the absorbing powers of different plants:

(a) Differences in the percentage composition of different types of plants grown on the same soil.

(b) Differences in the rate of absorption of an essential element for each unit of surface of absorbing root membrane.

(c) Total quantities of an element removed from a unit area or volume of soil.

(d) Ability to bring into solution undissolved components of the soil by means of the excretion of acid or disturbance of chemical equilibria.

(e) Ability to extend the root system into deeper layers of the soil and thus draw on a larger total amount of soil solution.

It is probably true in general that different types of plants grown on the same soil will contain different percentages of the elements absorbed from the soil, but these are merely end results which are observed, and if progress is to be made, a more critical analysis of the whole system is indispensable. Evidently various processes are involved both in the soil and in the plant, including not only mass action effects, but also those dynamic equilibria associated with living cells. We are probably justified in stating that no more complex system has ever been presented for scientific study. If it were really understood, almost every branch of science would have to render assistance.

Functions of Essential Elements

Any satisfactory theories concerning the response of different types of plants to the same culture media must rest, in part, on a knowledge of the functions of the essential elements, and we are forced to admit that such knowledge is far less adequate than we might rightfully expect it to be in view of the fundamental nature of the question and the extensive support which has been accorded to agricultural research. It is true that we have for many years been in possession of a good deal of information concerning the essential elements with respect to their presence in certain organic compounds, such as chlorophyll, protein, lecithin, etc., but only a small proportion of most of the essential elements is thus accounted for. The role of inorganic elements in helping to maintain suitable osmotic relations is well known, but we must proceed much further before we can explain the function of potassium, for example. Some progress has been made in one direction. Through the work of Loeb and others, we are now aware of the great importance of hydrogen ion concentration in influencing the colloidal behavior of proteins. There is much reason to believe that these findings may be of great importance to the study of plant metabolism, although such phenomena as those involved in the absorption of ions are far too complex to be explained on this basis alone.

Unfortunately, in studying the hydrogen ion concentrations of plants, it is impossible to separate out the cell sap of the higher plants in an uncontaminated condition, and we must be content with determinations made on the expressed juices. Obviously, these are mixtures and represent many types of living cells and also perhaps dead cells and intercellular material. In spite of these difficulties, the sap so obtained shows a general tendency to maintain a constant concentration of hydrogen ions. If the expressed sap be titrated with acid or alkali, it will be found that the buffer effect is of considerable magnitude. The study of plant buffer systems is by no means complete, but there is reason to believe that organic acids and the salts of these acids play the most important part in the buffer systems of the majority of agricultural plants, although other components of the system require investigation. The cations primarily involved are calcium, magnesium, and potassium, the potassium usually being present in much greater concentration than calcium or magnesium.

It would be a mistake to assume that the regulation of the reaction is dependent on calcium alone. It is undoubtedly true that in some plants, calcium does precipitate out organic acids formed as a result of the metabolism of the plant, but in many cases a very important proportion of the calcium remains in solution, even in plants supposed to have a special need for calcium. As J. D. Newton has shown, decreasing the supply of calcium does not necessarily increase the hydrogen ion concentration of the expressed sap. For the present, it is justifiable to state that all of these essential cations (Ca, Mg, K) are required in the buffer system. The possible importance of the phosphate, silicate and bicarbonate anions remains to be investigated more thoroughly. If bicarbonates are essential, they would not, perforce, have to be absorbed as such from without, since the reduction of nitrate would leave the necessary basic residue and the plant's metabolism would supply the CO_2. When the source of nitrogen is in the form of the cation NH_4, instead of the anion NO_3, this statement would not hold.

Another function of certain of the essential elements, particularly iron and manganese, presumably must be catalytic in nature. Such elements or their compounds may exist in specially reactive states, as has been suggested by some of the recent knowledge of atomic and molecular structure.

With regard to potassium, various speculations have been advanced. One of these is that this element possesses a very slight radio activity and owes its indispensable character to this property. This idea, however, still remains in a speculative stage, and some evidence against it has been adduced.

In considering the role of the essential elements in the synthesis of organic compounds by plants, you may recall that the statement has already been made that any plant may grow well in many solutions of different composition and that many diverse types of plants may all thrive in solutions of the

same composition. This, of course, must mean that in many cases excess quantities of one or more elements have been absorbed. As the term is ordinarily interpreted, a "best" solution for plant growth cannot be demonstrated, but some solutions might be more economical than others. It is interesting to inquire how plants differ in their ability to synthesize various organic substances with a restricted quantity of one or more elements. As you know, experiments and mathematical interpretations of the data have been brought forward in an attempt to answer questions of this character, but we may legitimately doubt the ultimate adequacy of any researches which do not throw some light on the synthetic biochemical processes in their relation to the essential elements derived from the soil. We have to consider the effect of one ion on the absorption of another, the possible limited replacement, physiologically, of one element by another, and especially the influence of climatic factors on the whole course of metabolism. One of the outstanding deficiencies of the data on plants grown for experimental purposes is the inability to evaluate and to compare climatic complexes. If means can be devised to control light, temperature, and humidity, progress will be far more secure. Attempts in this direction have been begun in England and also at the well endowed and uniquely equipped Boyce Thompson Institute for Plant Research. Certain experiments are being made in California, in a necessarily very limited way, since the expense involved is very great.

I have now attempted to sketch some of the facts and principles which have emerged so far from the investigation of plants grown in more or less exactly controlled artificial media. The use of these media has made it possible to gain some fairly definite ideas of the general nature of the solution environments adapted to the development of many plants of agricultural interest. This information is not only important in itself, but also bears very directly on the interpretation of soil solution data in terms of crop production. In the succeeding lecture, it will be my task to discuss some of the things we have learned about the soil solution in its relation to plant growth.

(Note: Part two of this paper will appear in the February issue.)

Quality in Apples.*

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The writer, having had many years' experience in making technical descriptions of apples, and, having tested literally thousands of varieties of named and unnamed sorts, has attempted in the following paper to describe his sensations when eating apples. While the use of certain terms is common to most authors who have published descriptions of apples, little has been written to explain what is meant by the terms used. While realizing that the descriptions of terms employed here are based, mainly, on personal opinion, it has been thought worth while to give them in the hope that something more accurate will come from a discussion of them. In attempting to describe quality, and by that we mean the sum of the sensations received when eating an apple, it is realized that no two persons would experience the same sensations. The quality of apples when cooked is not discussed in this paper.

Flesh

When one bites an apple, there is at first a sensation, due not to the juciness or flavour of the fruit, but to the texture of the flesh. This texture may be described by the terms tough, hard, firm, breaking, crisp, buttery, tender, soft, melting.

Tough—No apple with tough flesh, no matter how high the flavour, can be called of good quality, but toughness and high flavour

* Read to the American Pomological Society at Kansas City, Mo., December 8, 1925.

seldom go together. Some of the Russet apples come nearest to being tough of any of the high flavoured varieties of good quality. Tough flesh is just what it implies, a flesh that does not readily break up when one bites into it and which one is liable to swallow in large pieces rather than to have the delight of chewing, which is one of the very pleasant sensations of eating an apple which has tender flesh.

Hard—A hard fleshed apple is nearly as unpleasant to eat as one with tough flesh. Hard flesh may be described as being too firm to be pleasant to masticate, yet breaking up more readily than tough flesh, but lacking crispness. There are quite a number of the Russian varieties with this hard flesh, and it is common among crab apples. Lubsk Queen is a good example of a hard fleshed apple.

Firm—There are more firm fleshed apples among the winter varieties of high quality than in the summer or autumn sorts if one excepts the crab apples, and, even the best flavoured of these, the Whitney, has a relatively tender flesh. Some of the best firm fleshed apples, which will readily come to the minds of everyone familiar with apple varieties are the Tompkins King, Cox Orange, Grimes, Northern Spy, Esopus Spitzenburg, Stayman, Winesap, Yellow Newtown, Golden Russett, and others. Of summer and autumn varieties of commercial value, and their value is not great in America, the two Russian sorts, Tetofsky (summer) and Antonovka (autumn), are, with the exception of the crab apples, practically the only two which have firm flesh. Antonovka crossed with a soft fleshed winter variety, the Milwaukee, at Ottawa, has given varieties with firm or very firm flesh which keep longer than Milwaukee.

Breaking—A breaking flesh is one which breaks sharply when bitten, but does not break down readily, as when the flesh is crisp. The flesh of most of the named crab apples, such as Transcendent, Hyslop, and Martha, is breaking but not crisp. Breaking without crispness usually goes with the hard fleshed apples such as Lubsk Queen. Most of the firm fleshed varieties referred to above have a breaking, crisp flesh.

Crisp—A crisp flesh is most pronounced in firm fleshed apples, and does much to give the pleasant sensation which one gets in eating a firm, crisp fleshed apple. A crisp flesh may be described as a breaking flesh which breaks down or crumbles readily when bitten. Most of the firm fleshed apples referred to above would be considered crisp, throughout all of their season, but, among the tender fleshed apples, such as the Gravenstein, McIntosh and Delicious, the crispness is most marked when the apple is in the early part of its season.

Buttery.—There are more varieties of pears with buttery flesh than apples. It is hard to describe the term buttery, but the varieties Golden Delicious, Grimes, Yellow Bellflower, and Salome are four varieties having flesh which may be described by that term. The flesh of these and others, when being eaten, gives the sensation of the smoothness and consistency of butter. Apples with buttery flesh are usually among those which would be called moderately juicy.

Tender.—Tender flesh is just the opposite to tough flesh. It gives the sensation of breaking readily when eaten, and this, with their high flavour, is what does most to make Northern Spy, Tompkins King, Cox Orange, Esopus, Stayman, Winesap and Yellow Newton, Hubbardston, Jonathan and others so pleasant to the palate.

Soft.—Soft flesh is the opposite to firm flesh. Tompkins King is a typical firm fleshed apple; McIntosh a typical soft fleshed variety. Other soft fleshed apples are Fameuse, Delicious, Wealthy. The term "soft" is seldom used in describing apples. It is a term which might create an unfavourable impression in the minds of some people, hence the word "tender" is often used when the word "soft" would more nearly describe what is meant.

Melting.—Melting flesh is tender, soft flesh which gives the sensation of breaking down to such an extent that it seems to dissolve in one's mouth. Delicious, when in prime condition, is, perhaps, the most outstanding example of a variety of high flavour with melting flesh. Fameuse and McIntosh may also be put here.

Mealy.—Mealy flesh and tough and hard flesh give the least pleasant sensations in eating apples. Mealy flesh is usually noted when an apple is past condition, but some varieties, not among those of high quality

have flesh which, when in prime condition, may be described as mealy. A distinct sensation of mealiness in the flesh is obtained when one eats this type of apple.

Fine.—Certain varieties of apples give one the sensation of having fine grained flesh as opposed to others which have coarse flesh. Outstanding varieties, which appear to have fine grained flesh, are McIntosh, Fameuse, Northern Spy.

Coarse.—There are some varieties which, although having coarse or rather coarse flesh, have good flavour and other good characteristics which offset the coarse flesh. Among well known varieties which have relatively coarse flesh are Tompkins King, Baldwin, Jonathan, and Winesap. Without good flavour, a variety having coarse grained flesh does not make a popular dessert apple, but may be quite satisfactory for cooking, such as Duchess of Oldenburg.

Juiciness.—There are varieties which, when eaten, appear to be very juicy, as McIntosh; juicy, as Northern Spy; moderately juicy, as Baldwin, and occasionally the word "dry" is used, although there are few, if any, apples that may be called dry among varieties of good flavour. While one variety may give the sensation of being very juicy and another only moderately juicy when they are being eaten, a chemical analysis might show very little difference in the amount of juice. It must be remembered that we are writing of sensations, not necessarily of actual facts.

Flavour

The flavours that distinguish one variety of apple from another are very difficult, if not impossible, to describe. It is not so difficult, however, to approximate, at least, the degree of acidity or sweetness which each variety of apple appears to have when eaten, but the degree of acidity or sweetness, although grouped with flavour when describing apples, is not sufficient to identify an apple without knowing the distinctive flavour of the variety as well. The degrees of acidity which we use are acid, briskly subacid, subacid, mildly subacid, sweet, and very sweet. Sprightly is a term used to describe a sensation which adds to the pleasure of eating an apple. An apple might be acid or subacid and lacking in distinctive flavour, but, if it has sprightliness, it may be very pleasant eating. Astringent is another term which describes a puckery or astringent sensation, which is usually grouped under flavour. Other terms which better convey an idea of quality in a flavour are aromatic and spicy, but these only suggest those delicate flavours which have to be experienced to be appreciated. It is the subtle blending of these more or less volatile flavours with the best texture of flesh and degree of acidity that make high quality in an apple.

Acid.—The term acid is used to describe apples which are what is usually called sour. A few examples of these are Duchess of Oldenburg, Hibernal, and Arabskoe.

Briskly subacid.— Apples called briskly subacid are not quite as sour as those termed acid. Some varieties are Red Astrachan, Wealthy, Wagener, and Ontario.

Subacid.—Varieties which are subacid and which seem still less acid than the above are Fameuse, Esopus Spitzenburg, Roxbury, Stayman, Golden Russet, Yellow Newtown.

Mildly subacid.—There is quite a suggestion of sweetness in apples which are termed mildly subacid. A little acidity can be detected. Varieties which may be mentioned here are Delicious, Hubbardston, Westfield, Mann, Stark, York Imperial.

Sweet.—There are not many sweet apples in commerce to-day. The Sweet Bough and Tolman are the only two varieties that need be mentioned here.

Very Sweet.—Jersey Sweet might be put in this section. There some varieties not now in commerce which are so sweet that they might be termed sugary.

Aromatic.—The word aromatic is usually associated with flavour when describing fruit, but, as the name indicates, it is more a sensation through the nose than the palate. However, aroma is usually associated with apples of high flavour, and, in eating such, one gets the double sensation of a delightful smell and a delectable taste. Well known varieties which are aromatic are McIntosh, Delicious, Jonathan, Tompkins King, Northern Spy.

Astringent.—Astringency is usually associated with apples of inferior flavour such, for instance, as the Haas, but the Langford Beauty, a variety of the Fameuse group well known in Eastern Ontario, has good flavour, but is quite astringent or puckery, making an otherwise good apple rather unpleasant eating.

Sprightly.—Some of the very best varieties are sprightly in flavour, the sensation of sprightliness being often combined with other delectable characteristics such as crispness, tenderness, juiciness, aroma, and high individual or characteristic flavour. A sprightly apple may also be subacid, mildly subacid, or even sweet. Sprightliness imparts a sparkle to the flavour, which gives a very pleasant sensation, when the apple is being eaten. Following are some of the best varieties of apples that may be termed sprightly: Gravenstein, McIntosh, Cox Orange, Golden Delicious, Grimes, Northern Spy, R. I. Greening, Yellow Newtown.

Spicy.—The term spicy is meant to suggest that piquant flavour peculiar to spices in lieu of a word which would give a better idea of the kind of characteristic flavour which some of our best apples possess. The word nutty is also suggestive of this flavour. There is a suggestion of pears in these spicy apples. Some varieties which have spicy flavour are Cox Orange, Esopus Spitzenburg, Golden Delicious, Grimes.

Quality

Having described the sensations received when eating apples, let us see if it is possible to decide on what combination of sensations cause apples to receive the following terms used in describing them and which denote quality: Poor, below medium, medium, above medium, good, very good, best.

Poor.—While in our description work we have seldom called an apple poor in quality, and no named variety at present on the market would be described as poor, one that has tough, moderately juicy to dry flesh and is astringent and without characteristic flavour might well be called poor, and there are many unnamed apples of this character.

Below medium.—Apples which are below medium in quality have tough or hard flesh, or are too acid to be palatable and have no decided characteristic flavour. They are a little better than apples of poor quality, mainly due to more juiciness. Some which might be placed in this group are Hibernal, Arabskoe (Winter Arabka), Ostrakoff, and some other Russian apples. The quality of these has been called "medium in quality" in some of our publications, but this rating is too high except for parts of America where few varieties can be grown successfully.

Medium.—As indicating how much inferior the varieties marked below medium are to medium, the Ben Davis is included in this group, although some might make it below medium. The sensations which bring varieties into this group are lack of juiciness, lack of flavour, and astringency. Many varieties have been introduced which are only medium in quality when eaten raw, but make good apples for cooking. Following are some of these: Bismarck, Crimson Beauty, Ben Davis, Haas, Gano, and some of the Russian varieties.

Above Medium.—Most of the varieties which are above medium in quality have some distinct flavour, but the flesh is usually too coarse for eating raw, although it may have the desirable characteristics of crispness, tenderness, and juiciness. There are many apples in commerce which may be put here, practically none of which one would desire to eat raw where apples of good to best quality are available. The following are some of these: Alexander, Baxter, Duchess of Oldenburg, Gideon, McMahan, Milwaukee, Patten Greening, Wolf River.

Good.—Apples of good quality are enjoyed during the season when those of very good to best quality are not available. They give the pleasant sensations of crisp, tender, juicy flesh, a moderae acidity, and distinctive flavour. Some in this group are: Baldwin, Charlamoff, Dudley, Lowland Raspberry, R. I. Greening, Ribston, Rome, Roxbury, Wagener, Wealthy, Winesap, Yellow Bellflower.

Very Good. — There must be additional pleasant sensations to reach this group, those having crisp, fine grained, tender, juicy flesh and a high, pleasant flavour will be included here. Following are put in this group: Cox Orange, Delicious, Fameuse, Esopus Spitzenburg, Golden Delicious, Golden Russet

Grimes, Hubbardston, Jonathan, McIntosh, Northern Spy, Starking, Stayman, Tompkins King, Yellow Newtown.

Best.—Out of the very good, a few outstanding varieties may be selected which are considered "best", or that it is believed will give the most delightful sensations to the largest number of persons. Some prefer a firm, crisp fleshed apple. They will get it in the Cox Orange, Esopus Spitzenburg and Northern Spy. Others like a tender or soft fleshed apple with a fair amount of acidity. McIntosh will suit them. A great many people want a tender, soft fleshed, mildly subacid apple, and they will have their desire met to the full in Delicious and Starking. Golden Delicious comes between these in texture and acidity, and will, we think, suit the taste of most people. We venture to name in this group: Cox Orange, Delicious, Esopus Spitzenburg, Golden Delicious, McIntosh, Northern Spy, Starking.

It is self evident, we think, that the apples which give the largest number of pleasant sensations are the ones which are most likely to increase materially the consumption of fruit and these are found among those which have been called "Very Good" and "Best" in quality. It is the writer's experience, however, that in America at any rate the soft fleshed apples of high flavour are those which are most popular. These, especially the red varieties, are the kind the children prefer and it is through getting the parents to give the children all the apples they will eat that we believe the greatest increase in consumption will be brought about. Not only do children prefer the soft fleshed apples but there are very many adults who think they cannot eat a firm fleshed apple no matter how tender the flesh may be. We believe, therefore, that to increase consumption materially, a large proportion of the fruit should be of red apples such as McIntosh, Fameuse, Delicious, Starking.

Nitrogen Supply for Fertilizers.

(Contributed by the Dominion Seed Branch)

Nitrate of soda, sulphate of ammonia, tankage and cyanamid are the principal commercial fertilizer materials which supply nitrogen for plant growth. With the exception of the nitrate of soda all are made in Canada, and their production is much in excess of present demand. The following quantities were exported, mainly to the United States, during the past year: Sulphate of ammonia, 10,847 tons; tankage, 18,143 tons; and cyanamid 74,415 tons. Home consumption during the same period was estimated at 2,000 tons of sulphate of ammonia, 3,500 tons of tankage and 200 tons of cyanamid.

It is not likely that Canadian agriculture will require more nitrogen in chemical form than that which may be easily produced. Modern methods of fixation of atmospheric nitrogen have solved this question throughout the world. Canada has the distinction of having the only nitrogen fixation plant in operation on the North American continent, this being the cyanamid plant at Niagara Falls, Ont., where some 70,000 tons of cyanamid are produced annually. In addition to the possibilities of atmospheric nitrogen, the production of sulphate of ammonia has been limited only by the demand for this product. At present only five of the many steel and gas plants in Canada, where this valuable nitrogen material might be made, are equipped for its manufacture.

Nitrate of soda, which originates in the natural nitrate deposits of Chile in South America, may be expected to retain a permanent place as a nitrogen fertilizer, provided the supply continues at competitive prices. It occupies a favorable position in the market because its nitrogen is in the nitrate form which is readily available to plants. The Fertilizers Act controlling the sale of these products is administered by the Dominion Seed Branch.

An Apparatus for Microphotography.

A. SAVAGE

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This form of apparatus is commended to biological workers who occasionally desire to make microphotographs. It is simple and inexpensive, remarkably proof against vibration, and, in competent hands, capable of doing serious work. No claim is made for originality in any feature of it.

Aside from the microscope and accessories, it consists of two principal parts, a frame and a suspended 'deadlog' which serves as the optical bench. The former is essentially a table (22x44 inch top) with strong, square legs, well braced and peculiar in that these are not only placed directly at the corners but continued vertically beyond the table surface for about 20 inches.

The 'deadlog' is one solid piece of clear, well seasoned timber (7″x10″x44″) dressed on all sides, perfectly flat on its upper surface and painted dull black. It is slung at each end from the tops of the uprights by double thicknesses of inch-wide lampwick which pass beneath it so as to hold it suspended about an inch above the table top. Suitable iron fittings (D's) hold the wicking close to the sides of the 'deadlog' near its upper surface and thus eliminate the possibility of its upsetting when the optical parts are in place.

The illuminant is the only other feature of this set-up which deserves particular mention. It is a 32 candle power, 6 to 8 volt "Mazda" automobile lamp so mounted as to be adjustable in all directions and covered with a specially made hood of thin, sheet copper, having a half inch round hole in it for the passage of light. By means of a 40 or 50 Watt "toy transformer" (the kind sold for running children's electric toys off the usual 110 volt A. C. circuit) this lamp is operated at twice its rated voltage. It then provides a concentrated and brilliant source of light, unsurpassable for steadiness and, because of the copper hood, comparatively cool. Replacements are not often necessary.

Figure 1 shows the optical parts *in situ*. In front of the lamp housing is a holder for light filters. These have proved a necessity for almost every kind of work. A brass plate, suitably notched, and permanently screwed down, makes it possible to place the microscope in exactly the same position on each occasion with a minimum of time and effort. The camera illustrated is an obsolete model designed for 4″ x 5″ plates but serves the purpose excellently. It stands on a heavy iron base and can be moved at will. The microscope shown is a substantial English stand (J. Swift and Son) possessing two very important features for this kind of work. It has an excellent substage, and *all* its adjustments are accessible at the right hand side. The latter consideration is of very special merit.

Two white, rectangular figures on the side of the 'deadlog' show very plainly in the illustration. These are cards glued in place and marked with data concerning the transmission bands of light filters and the absorption spectra of commonly used stains.

If the objects placed on the 'deadlog' are naturally in stable equilibrium, there is no need to provide for clamping them down. Since there is no *inherent* vibration in the log itself, the fact that it is free to swing a little is decidedly conducive to getting good pictures even with prolonged exposures and under unfavorable conditions.

The building, in which this strange looking piece of furniture stands, is of iron frame construction with brick walls and concrete floors. It is crowded to capacity. Tramcars pass within 50 feet of it. Here, as elsewhere, students going downstairs sometimes jump the last few steps. Others have been known to slam doors. The additional vibration of a miniature grain separator in action on the floor below, and of a powerful centrifuge in the next room but one have also to be contended with at times. But this suspended 'deadlog' seems utterly indifferent to such disturbances and provides a means of getting satisfactory results which, with the conventional type of apparatus, would be impossible.

(NOTE. I am indebted to the Engineering Department of the Manitoba Agricultural College for the construction and fittings of the model described.

Mr. R. Mitchell kindly made the drawings shown in Figure 2.)

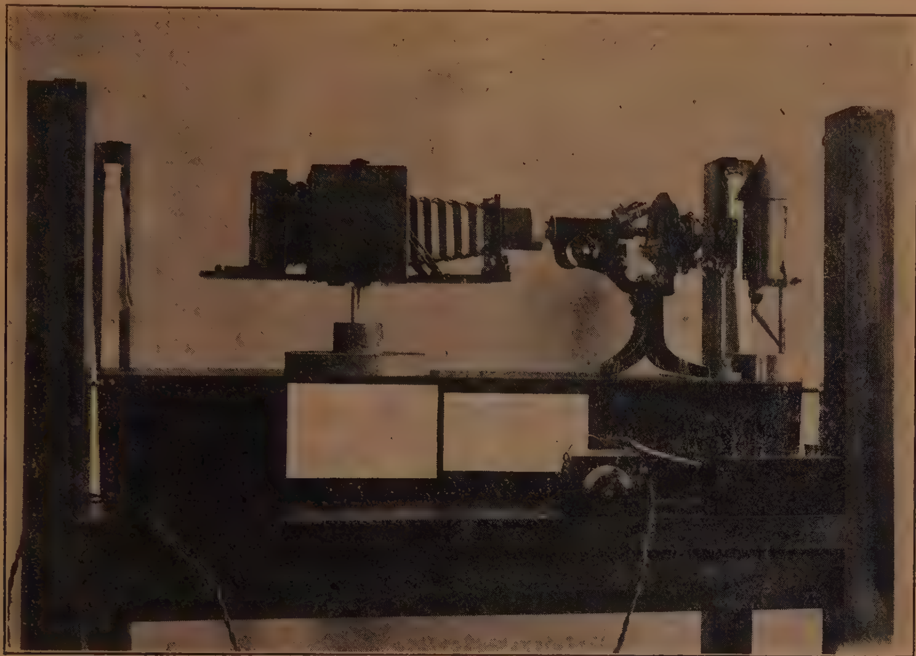

Figure I.

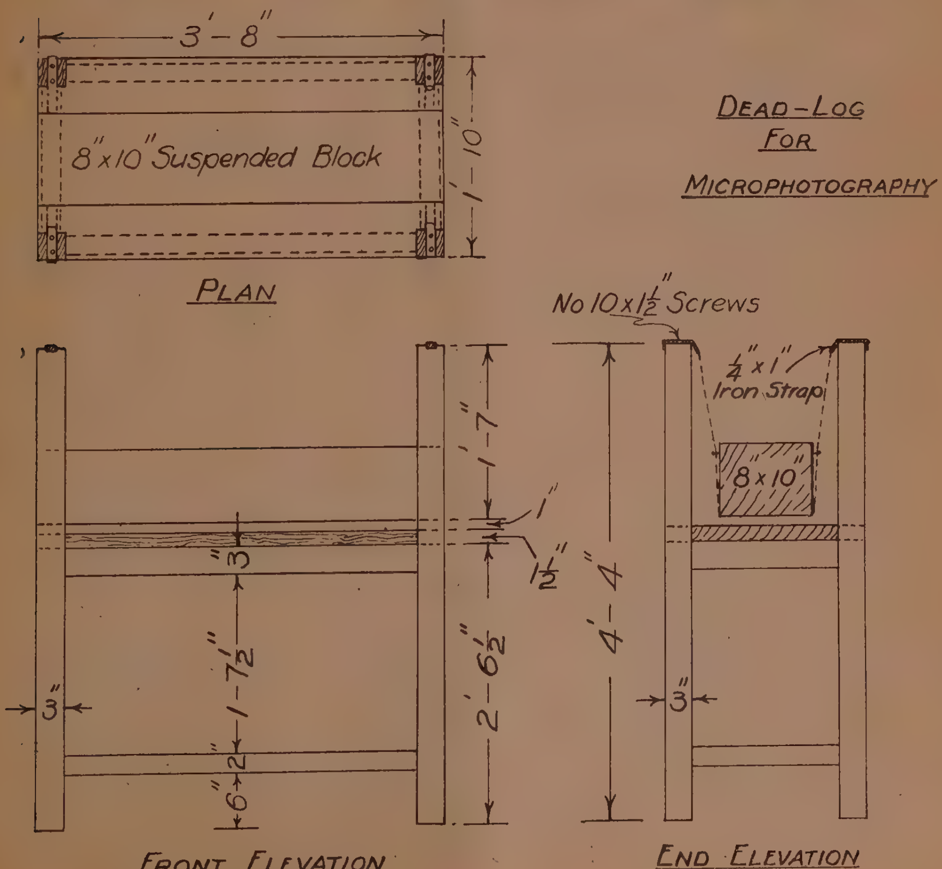

Figure II.

The Action of Rennet Extract on the Paracasein of Skim Milk, as Affected by Different Organic Acids.**

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INTRODUCTION

It has been definitely established that rennin is a proteolytic enzyme, and that in the manufacture of cheese, it not only coagulates the milk, but subsequently digests the paracasein.

In 1900, Babcock, Russell and Vivian (2) showed that, in the manufacture of cheese, an increase in the quantity of rennet used resulted in a more rapid production of soluble nitrogen compounds. They concluded from this that rennet exerts a digestive influence on paracasein. Jensen (11), working independently, arrived at similar conclusions. Shortly afterward, Van Slyke, Harding and Hart (12) made an extensive investigation into the action of rennet extract in the ripening of cheese, and in the conclusions of their publication make the following statement:—

"In the case of every experiment made, whether with cheese or milk, there was little or no proteolytic action of either rennet enzyme or commercial pepsin in the absence of acid; while there was marked action, though in varying degrees, in the presence of acid."

The interpolation "in varying degrees" applies to the fact that varying results were obtained with cheese of different ages. Barthel and his co-workers (4) conclude that bacteria belonging to the *Streptococcus lactis* group decompose casein at temperatures usually employed in storing cheese. They record as follows:—

"Presuming that the rapidity of the ripening process may be expressed by the amount of soluble nitrogen formed during a certain time of storage, we have established that the rapidity of the ripening of hard cheeses is directly dependent on the number of lactic acid bacteria in the cheese milk at the moment of adding rennet."

Later, in 1924(5), the same investigators published the results of further work, from which the following is cited:—

"From our experiments we may conclude that even if it is undeniable (as we have already shown in our previous paper) that an increase in the bacterial content of the milk at the time of curdling is followed by an increase in the rate of cheese ripening, it is likewise true, on the other hand, that an increase of the acidity in itself has a similar effect."

Working on the volatile acid production in cheese, Hart, Hastings, Flint and Evans (10) found that organisms isolated from Cheddar cheese produced large quantities of volatile acids. Evans (3) showed that *S. lacticus* formed a small quantity of acetic acid in milk subsequently confirmed by Hammer and Bailey (6), who also isolated an organism producing considerable amounts of volatile acid in pure culture, and in combination with *S. lacticus*.

In further work Hammer (7) concluded that a satisfactory starter cannot be made from *S. lacticus* alone, since this organism produces only a small amount of volatile acid. The addition of one or both of two associated types, which he named *S. citrovorus* and *S. paracitrovorus*, is required as these organisms produce a large quantity of volatile acid in milk, both alone and in combination with *S. lacticus*.

Hammer and Sherwood (8) found that starters ripened for considerable periods contained volatile acids made up largely of acetic

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* On graduation elected to the Wm. C. Macdonald Inc. Scholarship to be enjoyed in the Department of Bacteriology, Macdonald College, McGill University.

**Presented as a Thesis, done in the Department of Dairying, for the degree of Bachelor of Science in Agriculture of the University of British Columbia.

acid with small amounts of propionic acid. Also that the small amount of volatile acidity produced by *S. lactis* was made up of acetic acid with a large proportion of propionic acid. The associated organisms, *S. citrovorus* and *S. paracitrovorus*, produced a volatile acidity very largely acetic.

THIS INVESTIGATION

Object

The object of this investigation is to determine whether or not the volatile acids produced in starter vary in their activating influence on the digestion of paracasein by rennin, as compared with the effect of lactic acid. To a degree, the undertaking of the work is suggested by the lack of information as to the effect of different types of starters on the proteolytic action of rennin.

Materials

Skim Milk—Sweet separated morning's milk from the dairy herd of the University of B.C. was used entirely in these experiments.

Rennet—Dairy rennet manufactured by R. J. Fullwood and Bland, of London, England, was used in all the experiments.

A Stock Solution was prepared by diluting 10 parts of rennet with 90 parts of water. 2½% by vol. of chloroform was also added.

Vials—These were of glass, 3¼" high by ¾" diameter.

Acids—lactic—Baird and Tatlock, London,
acetic—B.C. Assay and Chem. Supply Co., Vancouver,
propionic—General Chem. Co., Easton, Penn.

Chloroform—B.C. Assay and Chemical Supply Co., Vancouver.

TABLE A.

The Effects of Weak Concentrations of Lactic, Acetic and Propionic Acids on the Digestion of paracasein by Rennet.

10 c.c. of skim milk held at room temperature for 7 days.

	% paracasein in the milk after one week	Average % of paracasein	Average % paracasein digested*
Milk	2.52		
	2.57	2.55	
	2.56		
	2.54		
" + rennet	2.45		
	2.42	2.44	4.31**
	2.45		
	2.43		
" + rennet + lactic acid	2.37		
	2.36	2.35	7.48
	2.35		
	2.33		
" + rennet + acetic acid	2.42		
	2.45	2.43	4.70**
	2.43		
	2.41		
" + rennet + propionic acid	2.36		
	2.35	2.36	7.08
	2.39		
	2.36		

* The percentage of total paracasein in the milk that has been rendered soluble.
** See discussion under (or following) Table B.

Methods

To each vial 10 c.c. of skim milk was added. This was supplemented by 3% by volume of chloroform, in order to kill all bacterial life. (No bacterial counts of the milk were afterwards made, as, in their work on the study of milk enzymes, Harding and Van Slyke (9) state definitely that 2½% by volume of chloroform in whole milk is sufficient to kill all bacterial life in 10 minutes.) The vials were then corked and left for 24 hours. Sufficient of the stock solution of rennet extract was then added to make the proportion of rennet extract to skim milk as 1:1,000. Immediately following renneting each vial of milk received 1 c.c. of a solution of either lactic, acetic or propionic acid, the strength being N/10 in the first experiment and N/5 in the second. All vials were corked and shaken, and then left at room temperature. Blanks of skim milk and chloroform, and skim milk, chloroform and rennet, were prepared and kept under similar conditions in each experiment.

At the end of a week the samples were all analyzed for paracasein. After dilution with 90 c.c. of water at 40°C., sufficient 10% acetic acid was added to each to make sure that all the casein was precipitated. After filtration the standard Kjeldahl method (1) was used in all the determinations.

EXPERIMENT 1a.

"THE DIGESTION OF PARACASEIN IN SKIM MILK BY RENNET AS AFFECTED BY WEAK CONCENTRATIONS OF THREE ORGANIC ACIDS."

To each vial, except the blanks, 1 c.c. of either N/10 lactic, acetic or propionic acid was added. The amount of the digestion of paracasein at the end of a week is shown in Tables A and B.

EXPERIMENT 1b.

Experiment 1 repeated with a fresh lot of skim milk.

TABLE B.

10 c.c. of skim milk held at room temperature for 7 days.

	% paracasein in the milk after one week	Average % of para-casein	Average % para-casein digested*
Milk	2.72		
	2.70	2.71	
	2.72		
	2.72		
" + rennet	2.58		
	2.57	2.58	4.80
	2.59		
	2.58		
" + rennet + lactic acid	2.48		
	2.51	2.50	7.74
	2.49		
	2.51		
" + rennet + acetic acid	2.52		
	2.52	2.53	6.64
	2.54		
	2.53		
" + rennet + propionic acid	2.53		
	2.50	2.50	7.75
	2.48		
	2.49		

* The % of total paracasein in the milk that has been rendered soluble.

Comparing Tables A. and B., it is obvious that the presence of acid causes a marked increase in the amount of paracasein digested by rennin. This statement must be qualified when considering the results obtained with acetic acid in Table A. No explanation of this suggests itself. At the same time, such a discrepancy is not noted in Tables B, C, or D.

In Tables A. and B., the results show that lactic and propionic acids have an equal activating influence on rennet.

EXPERIMENT IIa.

THE DIGESTION OF PARACASEIN IN SKIM MILK BY RENNET AS AFFECTED BY CONCENTRATIONS OF THE THREE ORGANIC ACIDS.

To each vial, except the blanks, I c.c. of either N/5 lactic, acetic or propionic acid was added. The amount of the digestion of the paracasein at the end of a week is shown in Tables C. and D.

TABLE C.

The Effects of Stronger Concentrations of Lactic, Acetic and Propionic Acids on the Digestion of Casein by Rennet.

10 c.c. of skim milk held at room temperature for 7 days.

	% paracasein in the milk after one week	Average % of para-casein	Average % para-casein digested*
Milk	2.53		
	2.52	2.52	
	2.53		
	2.52		
" + rennet	2.38		
	2.39	2.39	5.16
	2.40		
	2.41		
" + rennet + lactic acid	2.31		
	2.32	2.32	7.93
	2.33		
	2.31		
" + rennet + acetic acid	2.29		
	2.30	2.30	8.74
	2.30		
	2.31		
" + rennet + propionic acid	2.31		
	2.30	2.30	8.74
	2.29		
	2.29		

* The percentage of total paracasein in the milk that has been rendered soluble.

EXPERIMENT IIb.

Experiment II repeated with a fresh lot of skim milk.

TABLE D.

10 c.c. of skim milk held at room temperature for 7 days.

	% paracasein in the milk after one week	Average % of para-casein	Average % para-casein digested*
Milk	2.62		
	2.62	2.61	
	2.60		
	2.62		
" + rennet	2.48		
	2.49	2.49	4.60
	2.48		
	2.50		
" + rennet + lactic acid	2.40		
	2.41	2.40	8.05
	2.40		
	2.41		
" + rennet + acetic acid	2.38		
	2.39	2.38	8.82
	2.39		
	2.38		
" + rennet + propionic acid	2.37		
	2.38	2.38	8.81
	2.39		
	2.37		

* The percentage of total paracasein in the milk that has been rendered soluble.

In Tables C and D the results indicate that acetic and propionic acids have a slightly greater activating effect on rennet than has lactic acid.

The following observations suggest themselves on a consideration of Table E. The slight difference in the amount of paracasein digested in each experiment by rennet alone was probably due to the different milks used.

With lactic acid there is only a small increase in digestion with an increase in concentration of the acid amounting to about ½ of 1%.

Propionic acid in the low concentration shows much the same activating effect as lactic acid, but in the higher concentration it shows an increase over lactic acid of ¾ of 1%.

Acetic acid shows a very marked increase in digestion with increase in concentration. While having much less effect than lactic or propionic acids in the low concentration, it has fully as great an influence as propionic acid in the high concentration.

DISCUSSION OF RESULTS

This work confirms the findings of Van Slyke, Harding and Hart—that the digestive action of rennet on paracasein is markedly increased by the presence of acid. Furthermore, it also corroborates Barthel's recent work by showing that an increase in the acidity of the milk at the time of curdling causes an increase in the amount of soluble nitrogen compounds produced.

It has been found, as a result of these experiments, that in the lower concentration, lactic and propionic acids have a greater activating effect on rennin than has acetic acid, while in the higher concentration, acetic and

The results of Tables A. B. C. and D., are summarized in graphic form in Table E.

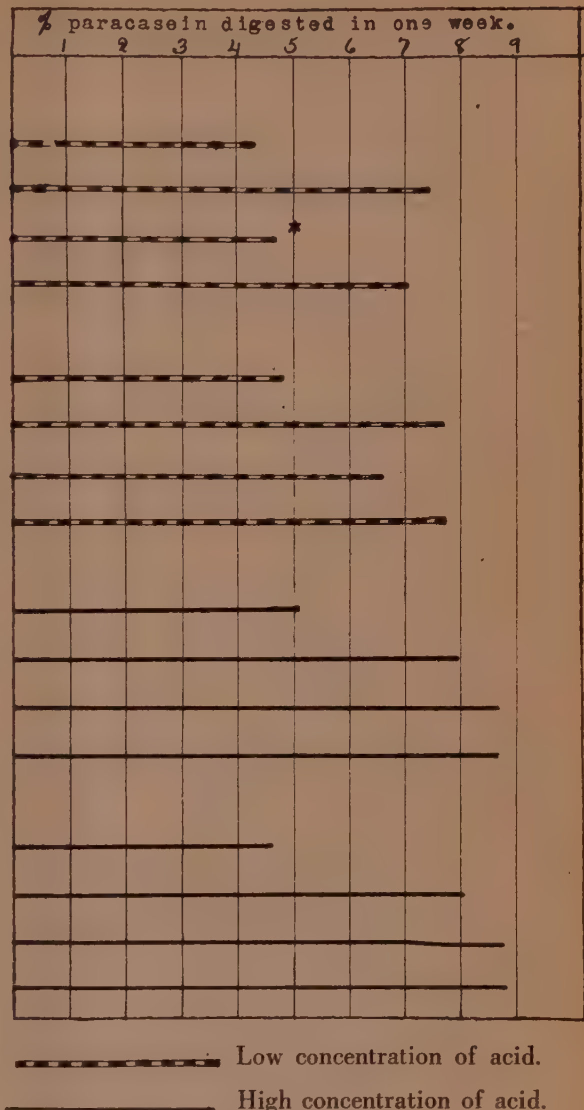
TABLE E

EXPERIMENT IA.
Milk + Rennet
" + " + Lactic Acid
" + " + Acetic Acid
" + " + Propionic Acid

EXPERIMENT IB.
Milk + Rennet
" + " + Lactic Acid
" + " + Acetic Acid
" + " + Propionic Acid

EXPERIMENT IIA.
Milk + Rennet
" + " + Lactic Acid
" + " + Acetic Acid
" + " + Propionic Acid

EPERIMENT IIB.
Milk + Rennet
" + " + Lactic Acid
" + " + Acetic Acid
" + " + Propionic Acid



* See discussion following Table B.

propionic acids show a marked increase in effect over lactic acid. Further work on this point is required, however, with concentrations of acid other than those recorded here.

CONCLUSION

The results of these experiments show that with an increase in concentration of acid in the milk at the time of curdling, a corresponding increase in the amount of paracasein digested by rennin is obtained.

ACKNOWLEDGMENT

The author desires to express his thanks to Professor N. S. Golding, under whose auspices this work was undertaken, for much valuable and constructive criticism during the course of this investigation, and in the preparation of the manuscript.

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VARIETIES OF SWEET CLOVER

In his pamphlet on "Sweet Clover", published by the Dominion Department of Agriculture, Mr. R. A. Derick, of the Brandon Experimental Farm, discourses interestingly on the varieties. There are many varieties of sweet clover, some very indistinct. There are annual and biennial white, as well as annual and biennial yellow-blossoming varieties. At present the demand is mainly for the biennial white type, commonly referred to as white sweet clover. The yellow is somewhat smaller, growing and maturing earlier than the white. It has also more tillers and a finer stem and leaf growth. Although not grown in Canada to any great extent, Mr. Derick says the yellow seems as hardy if not hardier than the white. It is usually believed, however to produce less forage.

Arctic, a white-flowered biennial variety that came from Northern Siberia has been developed at the University of Saskatchewan. While it is generally accepted to be excep tionally hardy, Mr. Derick says that at Bran don, this trait has not particularly shown i self because all of the biennial types c sweet clover tested have proved hardy. I maturity, he states that Arctic is slightly ear ier than the common white.

Hubam, a white-flowered annual, has r ceived considerable consideration of lat Tests at Brandon have shown that it requir a long season to reach full maturity and th the average growing season in Manitol would not permit full development of t crop. This variety grows rather early a later on produces a quick, rank growth th Mr. Derick suggests may prove useful sloug ed under as a green manure.

In a summary of his own pamphlet M Derick recognizes Arctic as a standard v iety and says that it has given favourable sults.

Dominion Department of Agriculture Notes

LIVE STOCK BRANCH

Dr. A. S. Morrison was transferred about November 1st this year from Alberta to Manitoba to take over much of the work in the older part of the province previously carried on by Dr. McLoughry. This work will consist of general live stock promotion work in select districts with special attention being given to cattle fitting periods in the winter months. It is also the intention that Dr. Morrison shall cooperate closely with market producers' organizations and dairy cattle producers' associations in an effort to improve the quality and to increase the production of the commercial dairy herds of the province.

Dr. McLoughry will during the next year or two devote most of his time to definite work in the Inter-lake region in cooperation with a special board on which the Dominion Department of Agriculture, the Provincial Department of Agriculture, the Soldier Settlement Board, the Canadian National Railways, Canadian Pacific Railway and Manitoba Live Stock Board are represented, the object being to find some solution, if possible, to the agricultural problems which have forced a large percentage of settlers in that part of the province to abandon their farms.

J. Harold Kezar who graduated from the Ontario Agricultural College in 1923, and who has been farming at Edenwold, Saskatchewan, for the past few years, has been appointed Junior Stock Yard Agent at the Southern Saskatchewan Co-operative Stockyards at Moose Jaw.

Among the more recent developments in Canadian agriculture, none is receiving greater prominence than the grading of farm produce. Egg grading, wool grading and hog grading are coming to be looked upon as forerunners to a wider application of the grading system, and in view of this fact, a short study of the results accomplished by egg grading should be of interest to agriculturists engaged in all phases of the industry.

In 1923 the domestic egg regulations with their standardized grading from producer to consumer, became law. In 1901, the per capita consumption of eggs in Canada was fifteen dozen and ten. In 1920, twenty years later, an increase of under one dozen had been recorded, making the per capita consumption sixteen doxen and eight. In 1924, after two years of application of the egg regulations by the Dominion Live Stock Branch, the per capita consumption of eggs was twenty-six dozen and one.

The result of this increased consumption has been a much steadier and more certain price to the producer. During the spring season of high production the dominating price factor has, in the past, been the inward storage movement. With the coming of June and the cessation of storage operations, the bottom falls out of the market until such time as production decreases. During the past year, however, a new factor has changed this situation. Immediate consumptive demand is now the dominating feature of the egg market at all seasons. When the inward storage movement stopped this year, consumption was such as to take up the burden of handling supplies. There was no price drop. A graph of this season's prices shows none of the inter-seasonal price fluctuations which have been a source of uncertainty to producers in the past.

Canadian poultrymen are offering graded eggs to the Canadian public. They have been rewarded by a greater demand for their product and, of equal significance, by a more even price return.

One of the outstanding achievements of the Live Stock Industry of Canada during the past twelve months had to do with the further re-establishment of our store and fat cattle trade with Great Britain. The Department

of Agriculture, which through the Live Stock Branch has laboured since the removal of the British Embargo in 1923, to actively develop this grade, reports that despite the high buying prices which ruled in Canada during the year, the returns from overseas shipments were in the main, extremely satisfactory and resulted in a continuous increase in shipments as the year progressed. The acceptance of the Departmental recommendation to the effect that only the best quality stock of uniform grading should be forwarded, resulted in a growing appreciation on the part of the British trade and feeder buyer, of the Dominion as a source of fresh meat and feeder supplies. Exports well exceeded the hundred thousand head, and the total for the year should reach 112,000, an increase of 34% over exports in 1924, and of 90% over 1923.

EXPERIMENTAL FARMS BRANCH

Division of Animal Husbandry

The Animal Husbandry Division of the Dominion Experimental Farms Branch endeavours at all times to foster, and, if possible, lead the way in any movement that is of interest and value to live stock breeders. Record of Performance for purebred dairy cattle is a case in point, as the number and high average of records made under the R.O.P. at the various Farms and Stations go to show. Special mention may be made of some of the outstanding records that have and are being made. Possibly the most outstanding is the World's Record, 30,886 pounds milk and 1,345 pounds fat in 365 days, formerly held by the Holstein cow, "Agassiz Segis May Echo"—41302—at the Experimental Farm, Agassiz, B.C. More recent achievements are the Canadian and living World's Champion Ayrshire three-year-old record of 17,406 pounds milk and 746 pounds fat in 365 days, made by "Primrose"—78274—, at the Experimental Station, Ste. Anne de la Pocatière, Que.; the World's Record of 9,013 pounds of milk and 524 pounds in 305 days just completed by the senior yearling Jersey heifer "Farleigh St. Mawes Retta"—21677—, at the Experimental Station, Summerland, B.C.; and lastly, the wonderful Canadian first-five-lactation cumulative record of 67,176 pound milk and 3,006 pounds fat of the Ayrshir cow "Starlight of Fredericton" —53712— bred at the Experimental Station, Frederic ton, N.B., and developed there and at th Central Experimental Farm, Ottawa. Th Advanced Registration of Dairy Sires Move ment has also received the same strong sup port with the consequence that there are no A.R. Class A, and, in some instances, Clas A.A. sires on practically all of the Farms an Stations, making possible a wide sale and dis tribution of A.R. sires from these Farms.

The Animal Husbandry Division, in co operation with the Division of Chemistry, an the Industrial and Development Council o the Canadian Meat Packers Associatior through Mr. S. E. Todd, has commenced a investigation into the character and causes o soft pork. The necessity for such a study i Canada is evident when it is reported by th Canadian packers that every year a certai percentage of the hogs marketed yield sof carcasses, which subsequently cure into sof or low-grade Wiltshire sides. The per cent age of soft carcasses has run as high as fiftee to twenty per cent in some years, which ha constituted a material loss to Canadian ex port trade. The breeding and feeding of th hogs in the experiment is being done by th Animal Husbandry Division on the Centra and various branch Farms. The chemical in vestigations are being conducted by Dr. F. T Shutt and help in the expert grading of th hogs in the experiment, both before and afte curing, is to be furnished by the meat pack ers. Investigations on soft pork were mad by Dr. Shutt and reported on in 1901. Thi study is still the most complete on the sub ject, but due to many changes in the method of breeding and particularly in the method of feeding hogs, it was felt that it would b advisable to carry on more work to complet the former study. The investigations will re quire a number of years of work before con clusions can be drawn, but it is hoped, whe it is completed, that much valuable informa tion on the character and causes of soft por will be available.

Division of Horticulture

Many of the new varieties of apples orig-nated in the Horticultural Division at Ot-awa are now fruiting at the Fredericton Ex-erimental Station and are being watched vith much interest by the fruit growers who esire better winter varieties for New Bruns-vick. Some of the varieties are very pro-nising. The Horticultural Division exhibit-d some sixty varieties of its new apples at he exhibition of the Quebec Pomological ociety held at Montreal in November.

During the past season Miss Ethel Hamil-on, Canning Specialist, has tested the rela-ive merits of many varieties of fruits for anning, jams, jelly and other purposes, in ddition to experimental work in dehydra-ion. Useful information has been obtained which it is hoped will be published in the ear future.

Division of Botany

A new bulletin prepared by Mr. John Adams will soon be off the press and it is ex-ected it will meet a large demand from the many thousands interested in the Canadian lora. Its title is "Survey of Canadian Plants n Relation to their Environment". The Botanical Division is asked each year to iden-ify many plant specimens gathered in every province in the Dominion. This new pub-ication will materially assist plant-collectors n identifying specimens. Members of the staff are engaged at present in preparing mat-er for another publication which will deal with the poisonous and edible mushrooms of he Dominion.

DAIRY AND COLD STORAGE BRANCH

The Division of Dairy Research during the past summer has been making an investiga-ion of different brands of rennet being used n Canada with a view to ascertaining the elative strength, purity and keeping quali-ies of the different brands. The same Divi-ion has also made analyses of several hund-ed samples of cheese with a view to deter-mining the average composition of highest rade Canadian cheddar cheese and of pro-ess cheese, and also the influence of char-acteristic defects on the composition of the cheese.

The Divisions of Dairy Manufactures and of Dairy Research have, for some time, been engaged in an investigation with the object of ascertaining the cause or causes of surface taint in butter and the conditions which favour the development of this taint.

Cereal Division

Among the numerous new wheat varieties under test by the above Division a variety called *Garnet* is receiving much public comment just now. Like most new wheat varieties which prove promising while under test *Garnet* has been given a reputation by many enthusiastic journalists which it will be difficult to live up to. Some have claimed, for example, that it is rust-resistant, which it is not. Others claim that it "undoubtedly will revolutionize wheat growing on the Prairies". Such a statement obviously is quite premature. A statement based on what is actually known and what is expected of this wheat is submitted below for the purpose of clearing up the doubt which must be entertained by many who realize the competition which a new introduction must face.

Red Fife Ladoga Onega Gehun

Preston A. Riga

Garnet

PEDIGREE OF GARNET WHEAT

The pedigree of Garnet, as illustrated is rather interesting. *Preston*, one of its parents, is potentially a fairly good yielder but lacks quality for bread-making purposes. It is also fairly early and seems to be able to thrive under dry conditions as a rule better even than Marquis. *Riga*, the other parent, matures very early, is only fairly productive, but possesses very fair quality. Onega, one of the parents of Riga, was obtained near Archangel, one of the most northerly wheat-growing districts of Russia. Gehun, the other parent of Riga, was brought from the Himalayas at an elevation of about 11,000 feet.

On the basis of tests made thus far *Garnet* seems to combine the "strength" and earliness of Riga with the good yield of Preston to a very considerable extent. It also shows some indication of having inherited the ability of Preston to cope relatively well with drought conditions.

Garnet is a beardless variety although it usually produces a few short fine awns at the apex of the head. Both flowering and empty glumes are unusually long thus giving the spike or 'head' a very characteristic appearance. The beak and shoulder of the outer glume are also quite distinctive. The kernels are hard, red and of medium size. They are smaller and usually somewhat lighter in colour than are those of Marquis and while not held so tightly in the "chaff" as are those of Marquis yet they do not appear to shell or 'shatter' easily. The straw does not seem to possess quite the strength of Marquis although it is regarded as a fairly strong-strawed variety.

In yield Garnet ranks among the best in tests conducted up to the present. Thus at the Experimental Farm at Brandon, Marquis, which heads the list in yield, has exceeded Garnet by less than 1 bushel on the average of the six year period 1919-1924. For the same period Garnet is behind Marquis at the Indian Head Farm by only about 2 bushels, while at Rosthern, Garnet has beaten Marquis by about a bushel. At Lacombe, Alberta, Garnet and Kitchener tie for first place on the average of the 4-year period 1920-1924, leading Marquis by a substantial margin. While these differences may not be significant statistically yet the yields as given indicate that Garnet may be regarded as a good yielder where conditions are at all suitable.

In date of ripening Marquis is forced to concede a decided advantage to the newer variety, being from 6 to 10 days later. It is in this respect chiefly that Garnet seems entitled to consideration.

In quality for breadmaking the flour the new variety appears to possess plenty "strength" although it does not possess the e treme whiteness that has distinguished Ma quis. It is not anticipated, however, that th will be a serious objection although the ut caution is being taken of having milling an baking tests made on a large scale to su plement the data accumulated by the Divisio itself from its own milling and baking lab oratory.

While the above variety seems quite su ceptible to rust, yet by reason of its earlines in ripening it frequently may escape the e fects of this disease. Something better tha an early-maturing variety seems necessar however before this scourge may be regarde with equanimity.

Unless some unforseen defect manifes itself, it is expected that Garnet will at lea take the place of Ruby as an early-maturin variety. Both sorts ripen about the sam time, but Garnet has a decided advantage i yielding having excelled Ruby in this respec by a substantial margin in practically all tes conducted to date. It also seems to shatte very little whereas Ruby is usually very ba in this respect.

In districts where an early sort is partic larly needed it is hoped that Garnet ma prove very valuable. As to how far it ma supplant varieties such as Marquis und other conditions still remains to be prove

SEED BRANCH

F. M. Overholt, B.S.A. (Toronto), forme ly employed with the Steele Briggs Seeds C is now Dominion Inspector for seed, fee fertilizer and binder twine with headquarte at Harriston, Ont.

E. H. Buckingham, B.S.A. (Alta.) is th Dominion Seed Inspector at the Provinci Seed Cleaning Plant, Edmonton.

O. R. Young, B.S.A. (Alta.) was recent appointed Inspector with the Dominion Se Branch, Calgary.

La Revue Agronomique Canadienne

RÉDACTEUR—H. M. NAGANT

Les Cicadelles—Ennemies de nos Plantes Potagères.

LIONEL DAVIAULT

Collège Macdonald, P.Q.

Les plantes potagères prennent, de jour en jour, une importance plus marquée dans l'alimentation humaine.

Outre qu'elles sont d'ordinaire d'un goût succulent, elles fournissent à tout l'être, des principes essentiels à son bon fonctionnement.

Aussi, à mesure que l'œuvre de l'éducation fait son chemin, nous voyons augmenter de façon notable la production, et partant, la consommation des produits potagers.

Mais, pouvons-nous dire que dans le Québec, et, plus particulièrement dans la région de Montréal, nous avons lieu d'être satisfaits de la production présente? Récoltons-nous suffisamment? Nous n'avons pas de statistiques précises à ce sujet, mais s'il faut en juger par les hauts prix commandés durant presque tout l'été, par certains de nos produits potagers, le céléri, la laitue, les épinards, par exemple, nous devons répondre négativement.

A quoi cet état de choses tient-il? Est-ce que l'étendue ensemencée n'est pas suffisante? Est-ce plutôt dû au fait que nos maraîchers ne sont pas assez habiles pour obtenir de cette culture, des profits vraiment rémunérateurs? A notre humble avis, l'une des plus sérieuses entraves à l'exploitation maraichère dans le district de Montréal serait plutôt la présence désastreuse et mal combattue d'insectes nuisibles, tels que les cicadelles, ravageant sans merci nos plus beaux champs de céleri, de laitue, etc. Qu'advient-il donc du pauvre ecploitant ayant mis toutes ses espérances dans son jardin? Découragé, vaincu par une série d'échecs lamentables, il abandonne son travail qui ne lui a apporté qu'amères déceptions. C'est là le cas malheureusement trop réel qu'il nous a été donné de constater durant notre travail, l'été dernier, pour le Département provincial de l'Entomologie.

Le Département, en effet, sur les pressantes demandes de nombreux et malheureux producteurs, résolut au printemps dernier, de mener une vigoureuse campagne contre ces cicadelles dévastatrices de nos jardins québecquois.

Nous avons eu le devoir d'étudier ses ravages sur place. Suggérer un ou des moyens de contrôle pratiques et très à point serait chose hasardeuse après une seule année d'observations.

Nous nous contenterons dans le présent écrit de faire connaître le résultat de nos observations personnelles et les moyens de contrôle que nous avons cru bon d'enseigner à nos patients.

Classification des Cicadelles et leur Distribution:—Les Cicadelles, appelées vulgairement par les jardiniers *mouches du céleri*, représentent une famille très importante d'insectes appartenant à l'ordre des Homoptères. On distingue facilement les individus de cette famille, de tous les autres insectes de même taille trouvés dans les jardins, par leur façon particulière de s'envoler qui ressemble beaucoup au saut d'une sauterelle.

La famille des Cicadellidées comprend un très grand nombre de genres, subdivisés eux-mêmes en un grand nombre d'espèces. Toutes les espèces de Cicadelles ne se rencontrent pas

dans nos jardins; en fait, nous n'avons eu à nous occuper l'été dernier, que de quelques-une d'entre elles; citons, *Cicadula sex-notata*, (Fall), *Helochara communis* (Fitch), *Empoasca mali* (Le Baron) et *Parabolocratus viridis* (Uhler).

Les localités les plus affectées, aux alentours de Montréal, semblent être St-Michel, St-Hubert, St-Vincent de Paul et Ste-Rose. Durant toute la saison de végétation, on peut observer à ces divers endroits des milliers de cicadelles. Elles s'attaquent indifféremment et aux mauvaises herbes et aux plantes cultivées. Cependant elles choisissent leurs hôtes; ainsi, elles semblent affectionner de façon toute particulière l'amarante à racines rouges et le vulgaire choux-gras. Parmi les plantes potagères, la laitue, l'épinard et le céleri sont le plus souvent attaqués.

Cicadula sex-notata (Fall):—Cet insecte est très connu en Europe. En Amérique, il se rencontre depuis l'Alaska jusqu'en Floride, nous en avons fait de nombreuses collections l'été dernier, durant les mois de juillet et d'août. On le voit un peu partout, dans les pâturages, les champs d'avoine, etc., et il ne semble limité dans sa distribution à aucun genre de sol particulier.

Cette Cicadelle est de couleur jaune verdatre; elle se distingue facilement des autres cicadelles plus haut mentionnées, par la présence de six taches noires qui lui ont valu son nom spécifique. Deux de ces points sont situés à l'arrière partie du vertex, une autre paire est placée transversalement à peu près au tiers inférieur du front; enfin, l'autre paire, également transversale, est située à la jonction du front et du vertex. Les élytres en cette espèce n'offrent aucun caractère morphologique très remarquable. Noir en-dessous, le corps est de couleur jannâtre au-dessus. Le dernier segment abdominal est différemment constitué dans les deux sexes; il est long, convexe et de couleur jaune chez la femelle, mais court et couvert de poils blanchâtres chez le mâle.

Les nymphes, à leur maissance, ont à peu près la forme des insectes adultes sauf qu'elles sont privées d'ailes.

Helochara communis (Fitch):—Cette Cicadelle, vulgairement appelée *cicadelle de la tourbe* (Bog leafhopper), semble s'adapter exclusivement aux terrains très riches en humus. A St-Michel et à St-Hubert, elle se trouve en grand nombre dans les jardins durant le mois de juillet.

La Cicadelle de la tourbe est une très petite espèce, de couleur vert foncé avec des striations transversales sur le front. Pour le reste,

lle ressemble beaucoup a l'espèce précé-ente.

Les nymphes sont de couleur vert pâle vec des striations peu marquées sur le front. es rudiments d'ailes atteignent à la dernière que le troisième segment abdominal.

Empoasca mali (Le Baron):—Voilà un nsecte des plus jolis mais aussi des plus ommageables. Aux Etats-Unis, cette cicad-lle est la cause d'une maladie très désas-reuse de la Pomme de terre, *l'Hopperburn*. n 1919, d'après Kotila*, cette maladie aur-it réduit de 3.7% la récolte de pommes de erre totale aux Etats-Unis, soit à peu près 6,348,000 boisseaux. Dans certains états, lle aurait été particulièrement dommageable, insi l'état du Massachusetts, cette même an-ée, perdait 25% de sa récolte. Heureuse-nent pour nous, elle n'est pas abondante dans e Québec.

Les adultes de cette espèce sont de très etite taille, un-huitième de pouce de long, out au plus, et de formes délicates. La ouleur générale du corps est d'un vert très rillant. Le front est arrondi, les élytres ninces, uniformes, serrées sur le corps, les attes délicates.

Les nymphes diffèrent peu des adultes, uant à la forme: la couleur cependant est 'un vert encore plus clair.

Nocuité:—Dans les régions où abondent es Cicadelles, elles sont tenues respondables e toutes les taches trouvées sur les plantes ultivées, particulièrement chez le céleri. 'outefois, on doit se rappeler que la grande najorité des taches sur le plant de céleri ont dues à la présence d'un champignon. Ceci s'explique assez bien, le jardinier voy-nt les cicadelles continuellement voltiger sur es champs, est porté à leur attribuer les ertes qui l'affectent. Il est impossible pour ui d'en accuser les champignons qu'il ne oit pas.

L'appareil buccal des Cicadelles est adapté la succion. Pour s'alimenter, l'insecte in-roduit son suçoir au sein des tissus et en spire les sucs nutritifs. Autant de ces pi-ures, autant de trous faciles à remarquer à a loupe sur une feuille affectée. On peut ussi remarquer, bien que moins importantes, es blessures de l'ovipositeur.

Les plantes ne réagissent pas toutes de la même façon à la piqure de l'insecte. Chez la laitue et l'épinard elle est suivie d'une brûlure comparable a celle produite par le soleil. Les Phytopathologistes ont donné le nom de *Hopperburn* à ce genre de brûlure qui affecte la pomme de terre.

On n'est pas encore bien fixé sur la nature de cette brûlure mais probablament est-elle le résultat d'un empoisonnement. Le poison, injecté dans la plante, lors de ces piqures de l'appareil buccal, se répandrait dans tout l'organisme.

Les rares taches que nous avons trouvées sur le Céleri ressemblaient à celles trouvées ordinairement sur l'avoine. Osborn a étudié le développement de ces taches sur l'avoine "Elles sont de couleur blanchâtre à leur ap-parition, puis elles deviennent peu à peu jaunâtre, enfin brune et parfois même noire. Le plus souvent elles apparaissent sous la forme d'une tache noire ou brunâre au cen-tre, ceinturée d'une bordure rouge ou jaune." Dans ce dernier cas, elles ressemblent beau-coup à une tache produite par la rouille et il devient difficile au novice de les différencier.

Qu'elle soit généralisée ou localisée, cette brûlure réduit de beaucoup l'apparence du produit sur le marché et en déprécie les prix proportionnellement.

Cycle évolutif de la Cicadelle a six points: Comme il a dejà été dit, la Cicadelle à six-points se rencontra en grand nombre l'été dernier; vu son grand nombre, nous avons limité nos observations à ce dernier insecte.

Les facteurs écologiques: sol, température et humidité, influencent grandement le dé-veloppement des diverses générations. Aussi devient-il impossible de prévoir à l'avance la date de leur apparition ni leur durée.

Les adultes et les nymphes passent l'hiver dans les pâturages, et sous les débris de toutes sortes laissés dans le champ. De bonne heure au printemps, ces individus apparaissent, com-plètent leur développement et les femelles commencent à pondre sur les herbes avoisinant leur quartiers d'hiver. Leurs petits oeufs sont introduits, quatre ou cinq à la fois, grâce à l'ovipositeur, sous l'épiderme de la feuille. Ils sont généralement disposés en rangées superposées, mais on peut aussi les trouver dispersés çà et là sur la feuille. L'œuf, en se développant, produit de petites protubérances,

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Leafhopper Injury to Potatoes—By J. E. Kotila Technical Bull. No. 56, Michigan Agric. Exp. Station.

facilement remarquables à l'œil nu. Examinées avec une loupe, deux petits points noirs font contraste sur le fond transparent de la tache.; ces deux points correspondent aux yeux. Sous la chaleur bienfaisante du soleil, ces œufs éclosent, donnent naissance à des nymphes de .6 à .7 mm. de longueur. Ces nymphes ont la tête large et le front arrondi. Le prothorax est de même longueur que la tête, mais le mésothorax et le métathorax sont tous deux plus petits. Les côtés du métathorax s'étendent en arrière. Les antennes atteignenent l'abdomen. La couleur générale du corps est grise.

Ces nymphes ne font pas grand tort à la plante. Mais en croissant elles deviennent dangereuses. A chaque mue, la couleur et la forme du corps changent quelque peu, et c'est à la dernière i.-e. la quatrième que la nymphe devient adulte. Nous en avons donné une longue description plus haut.

Ces adultes, les premiers dix jours, ne font que manger. Mais bientôt ils s'accouplent et la femelle commence la ponte. Apparait alors une nouvelle génération. Celle-ci peut-être suivie d'une troisième. D'après Osborn, il se produirait dans l'état du Maine, et probablement ici, une quatrième génération qui n'aurait cependant pas le temps de compléter son développement. Les nymphes de cette quatrième génération et les adultes de la troisième, hivernent et propagent l'espèce l'année suivante.

Moyens de les combattre:—En face des terribles ravages causés à nos plantes potagères par ces insects, il faut songer aux remèdes. Ce n'est pas chose facile à trouver dans le cas d'insectes suceurs tels les cicadelles. Les insecticides de contact ont bien un heureux effet sur les nymphes qui ne peuvent s'envoler. Il n'en est plus de même avec les adultes qui peuvent s'éloigner facilement.

Le meilleur moyen de les combattre, est de recouvrir la plante, pendant toute la période de végétation, d'une substance capable d'empêcher l'insecte de s'y poser. Le répulsif doit être à la fois peu coûteux et facile d'em-ploi. La Bouillie Bordelaise remplit bie ces deux conditions, et, de plus, elle a l'avan age de combattre en même temps les mala ies. Depuis longtemps la Bouillie Bordelai est employée pour combattre les cicadelle c'est le traitement type de la cicadelle d la pomme de terre.

L'été dernier, elle s'est montrée très eff cace avec des applications sagement distr buées. La plante doit être continuellemen recouverte de la matière, pour cela il fa répéter les arrosages presque tous les d jours et arroser copieusement les deux côt à la fois. Pour faire un bon travail, il n'e pas nécessaire d'acheter des instruments bie coûteux, un pulvérisateur à bras ordinaire fa très bien l'affaire.

Dans la lutte contre les insectes, la ten ance actuelle, semble être l'emploi des pou res. Elles sont plus économiques et pl faciles d'emploi. Dans nos expériences d contrôle, plusieurs furent essayées, mais a cune ne s'est montrée supérieure à la Boui lie Bordelaise. Cependant on ne peut en ployer autre chose lorsque les plantes do vent être expédiées bientôt sur le march Elles ne laissent, en effet, qu'un léger résid facilement enlevé par un bon lavage à l'ea courante.

Le Soufre Précipité Nicotiné, de Schloe ing, semble préférable à toutes les autr poudres. On peut s'en procurer facilemen sur le marché, à l'heure présente; C'est u poudre de couleur brun très foncé et a particules extrêmement fines. Avec une sa poudreuse à bras ordinaire, on peut faire u excellent travail en très peu de temps.

RESUME

1. Les cicadelles sont très abondantes da la région de Montréal et sont la cau d'une brûlure importante qui affecte n plantes potagères.
2. Comme moyens de combattre ces insecte on peut conseiller la Bouillie Bordelai et le Soufre Précipité Nicotiné.

NOUVELLES DE NOS ECOLES D'AGRICULTURE

A la dernière réunion des membres de la Société Entomologique d'Ontario, tenue à Ottawa, le R. P. Léopold, O.C., Directeur de l'Institut Agricole d'Oka, a été élu à l'unanimité président de cette Société. Nous offrons nos sincères félicitations, au nom de toute C.S.T.A., au R. P. Léopold pour cette distin tion dont l'honneur rejaillit en particulier s les techniciens agricoles de la province Québec.

.A CAMPAGNE DE RECRUTEMENT DE LA C. S. T. A.

Lorsqu'au printemps dernier le recrutement de 50 nouveaux membres Canadiens rançais dans la C.S.T.A. s'imposa comme objectif, la chose fut acceptée avec un grain de el. Il faut toujours mettre la mire plus haut que le point réellement visé, se disait-on; oute trajectoire parabolique monte pour commencer, mais elle descend infailliblement ensuite.

Pour un fois, cet axiome élémentaire de la cience balistique semble avoir été renversé. .a courbe décrite par notre campagne de recrutement n'a pas cessé de s'élever, en effet; c'est-à-dire que, se moquant de toutes les règles de la géométric, elle n'a pas entendu rester parabolique.

Voila qui explique qu'à la mi-décembre, au ieu de 50, nous atteignions le chiffre de 62 nouveaux membres canadiens français inscrits depuis le 1er. avril.

Mais la raison de cette obstination parabolique! dira-t-on? Elle ne s'explique évidemment que par le zèle déployé dans les diverses sections de la province, et par l'esprit de corps et de solidarité dont ont fait preuve en l'occurrence les techniciens agricoles en général.

Aussi, en adressant nos meilleurs voeux de bonheur à tous les membres de la C.S.T.A., pour l'année nouvelle qui commence, nous y ajoutons, au nom de toute la société, un bien cordial merci à un chacun pour la part acquise dans le grand succès qui marque notre entrée dans cette année 1926.

ACTIVITES DES SECTIONS

Section de Ste. Anne de la Pocatière

Nous apprenons que la section de Ste. Anne de la Pocatière en est déjà à son deuxième diner-causerie depuis sa naissance.

Le premier a eu lieu le 12 novembre, le conférencier était monsieur L. Ph. Roy, chef du Service de la Grande Culture au Département de Québec. La seconde réunion se passa le 19 décembre, avec le Dr. Auguste Pépin, analyste en chef au bureau fédéral des Semences à Québec, comme orateur.

Nous espérons avoir bientôt un rapport plus circonstancié de ces témoignages d'entrain donnés par la jeune section.

Extrait du livre des procès-verbaux de la Section de Ste-Anne:—

PROPOSE par M. Bernard Baribeau,
SECONDE par M. Lépold Raynauld,

Que les membres de la Section de Ste-Anne de la C.S.T.A. ont appris avec beaucoup de regret la mort de Monsieur J. E. Pintal, leur estimé confrère, et que copie de la dite résolution soit envoyée à la famille en deuil et à la Revue Agronomique Canadienne pour publication.

IN MEMORIAM
ERNEST PINTAL

Tous ceux qui ont passé à l'Institut Agricole d'Oka, entre les années 1913 et 1917, se rappelleront d'Ernest Pintal, ce grand garçon qui riait de si bon cœur en écarquillant les yeux dans toute leur largeur. Comme d'autres déjà, hélas! il vient de payer son tribut au dévouement sans limites dépensé dans la carrière agronomique qu'il exerçait dans le comté de Rimouski, avec un zêle et un esprit d'initiative auxquels tous rendaient hommage.

Outre l'accomplissement des devoirs ordinaires qui incombent à un agronome de district, Pintal s'était spécialement occupé de l'amélioration des conditions de production des pommes de terre, industrie agricole si importante, comme on sait, dans la région de Rimouski.

C'est à cette occasion notamment qu'il s'imposait de passer des journées entières dans les caves froides et humides, à l'effet de montrer et de pratiquer pour les cultivateurs les méthodes de sélection et de traitement des tubercules.

Son tempérament délicat ne put résister à cette épreuve. Il y a quelques mois, Pintal tombait d'un mal reconnu immédiatement inexorable par tous ceux qui eurent l'occasion d'approcher notre confrère.

Avec Gustave Couture, enlevé par une mort aussi tragique que prématurée, Ernest Pintal est le deuxième gradué de la promotion de 1917 à l'Institut Agricole d'Oka, qui disparait dans l'espace d'un an et demi.

A la famille éplorée de notre cher confrère, nous adressons l'hommage de notre profonde sympathie. Puissent l'estime et les regrets unanimes qui resteront attachés à sa mémoire adoucir quelque peu l'affliction de ceux qui le pleurent.

H.M.N.

Concerning the C.S.T.A.

APPLICATIONS FOR MEMBERSHIP

During the month of December the following applications for regular membership have been received and will be referred to the Membership Committee on December 31st:

Addison, F.W. (Alberta, B.S.A.) Mannville, Alta.
Anderson, J.W. (Manitoba, 1925, B.S.A.) Treesbank, Man.
Buckley, E.N. (Toronto, 1923, B.S.A.) Smith Falls, Ont.
Chamberlain, G.C. (Toronto, 1922, B.S.A.) Toronto, Ont.
Cline, C.A. (Toronto, 1922, B.S.A.) Hamilton, Ont.
Davidson, J. G. (Saskatchewan, 1921, B.A., 1924, B.S.A.) Saskatoon, Sask.
Devine, J.W. (Saskatchewan, 1925, B.S.A.) Saskatoon, Sask.
Devlin, T.P. (Alberta, 1925, B.S.A.) Winnipeg, Man.
Eaton, E.L. (Toronto, 1920, B.S.A.; McGill, 1925, M.S.A.) Upper Canard, N.S.
Flock, J.A. (Toronto, 1918, B.S.A.) Guelph, Ont.
Foster, L.H.H. (Alberta, 1924, B.S.A.) Olds, Alta.
Fraser, J.F. (Toronto, 1923, B.S.A.) Kemptville, Ont.
Francis, J.F. (Toronto, 1915, B.S.A.) Guelph, Ont.
George, W.B. (Toronto, 1923, B.S.A.) Walkerton, Ont.
Greaney, F.J. (Toronto, 1922, B.S.A.) Winnipeg, Man.
Harris, G.H. (British Columbia, 1922, B.S.A.; Oregon, 1923, M.S.) Vancouver, B.C.
Harrison, K.A. (Toronto, 1924, B.S.A.; McGill, 1925, M.Sc.) Macdonald College, P.Q.
Hood, G.B. (Toronto, 1920, B.S.A.) Toronto, Ont.
Johns, C.K. (Alberta, 1925, B.S.A.) Macdonald College, P.Q.
Kellough, J.Y. (Toronto, 1925, B.S.A.) Fordwich, Ont.
Limoges, D. (Montreal, 1925, B.S.A.) Rimouski, P.Q.
Malloch, J.G. (Alberta, 1924, B.Sc.) Edmonton Alta.
Marcellus, F.N. (Toronto, 1911, B.S.A., 1925, B.V.Sc., V.S.) Guelph, Ont.
MacIsaac, F.M. (Saskatchewan, 1923, B.S.A.) Scott, Sask.
McCallum, J.M. (Toronto, 1923, B.S.A.) Ottawa, Ont.
Phaneuf, U. (Montreal, 1922, B.S.A.) Rimouski, P.Q.
Porter, A.M. (Toronto, 1920, B.S.A.) Guelph, Ont.
Roch, Rosaire (Montreal, 1922, B.S.A.) Joliette, P.Q.
Russell, R.C. (Saskatchewan, 1924, B.S.A.) Saskatoon, Sask.
Sanford, G.B. (Alberta, 1920, B.S.A.; Minnesota, 1923, M.S., 1925, Ph.D.) Saskatoon, Sask.
Scannell, J.W. (McGill, 1921, B.S.A.) Saskatoon, Sask.
Senn, W.E. (Toronto, 1923, B.S.A.) Essex, Ont.
Singleton, J.F., Chief, Division of Dairy Markets and Cold Storage, Dept. of Agriculture, Ottawa, Ont.
Smith, C.W. (Toronto, 1924, B.S.A.) Chatham, Ont.
Steckle, John (Toronto, 1920, B.S.A.) R.R. 2, Kitchener, Ont.
Stothers, S.B. (Toronto, 1916, B.S.A.) Clinton, Ont.
Townsend, C.T. (British Columbia, 1925, 1925, B.S.A.) Macdonald College, P.Q.
VanEvery, W.S. (Toronto, 1922, B.S.A.) St. Catherines, Ont.
Watt, M.A. (Toronto, 1925, B.S.A.) R.R. 3, Waterford, Ont.
Wilson, L.T. (Saskatchewan, 1924, B.S.A.) Saskatoon, Sask.
Wyatt, F.A. (Illinois, 1915, Ph.D.) Edmonton, Alta.

Student Members

In the November, 1925, issue we published a list of those who had become student members (*) up to October 31st. The following have joined since that date:

At the Manitoba Agricultural College: N. M. Fowler, R. M. Scott, J. W. Walster, Roy West. (4).

At the Ontario Ontario Agricultural College: H. H. Hannam. (3)

At Macdonald College: Miss Gertrude Russell. (3).

At the University of Alberta: C. O. Asplund, W. H. Cook, J. R. McFall, K. L. Prior. (11).

At the University of Saskatchewan: E. Grest, R. Moar, W. C. Wood. (3).

At the University of British Columbia: F. Mutrie (1).

At the Oka Agricultural Institute: H. L. Bérard, R. L'Ecuyer, P. O. Roy, J. M. Alvarez St. Denis. (4).

At Ste. Anne de la Pocatière, P.Q.: L. Lafrance (10).

The membership at the agricultural colleges is given in brackets above, after each institution. The total number of Student members is 39.

CLOSE OF MEMBERSHIP CAMPAIGN

There are few members who do not know that the Society has been conducting a membership campaign during the past few months. The campaign started with the distribution of the C.S.T.A. Booklet in September, has been continuous since then and closes with the introduction of a $5.00 initiation fee on January 1st. After that date all organized effort to increase membership will be directed toward graduates of one year's standing, as they are the only eligible members exempt from the initiation fee.

At the time of writing (December 28th) there remain several days during which the results of the membership campaign will continue, and probably the list of new members published in our next issue will be fairly large. At present the actual membership of the Society is 889, of which 39 are Student members. The objective of 1,000 members might have been more nearly reached had the names of 45 members not been removed from the active list through delinquency in fee payments, removal to other countries, and for other reasons.

During the past six months 150 regular members have joined the Society. Applications have come chiefly from Alberta, Manitoba, Saskatchewan, Ontario and the French sections of Quebec. The present distribution of members is as follows:

Alberta		82
British Columbia		58
Manitoba		63
New Brunswick		30
Nova Scotia		29
Eastern Ontario	112	
Western Ontario	114	232
N. Western Ontario	6	
Prince Edward Island		9
Quebec (French)	160	
Quebec (English)	57	217
Saskatchewan (N.)	45	
Saskatchewan (S.)	52	97
Outside of Canada		33
		850
Student members		39
Total Membership		889

The distribution of Student members is shown elsewhere in this issue.

The General Secretary is now preparing an alphabetical list of the members, with their addresses This booklet will be sent to each member as soon as it is ready and should serve as a very useful reference medium.

Immediately after the list of members has been distributed, steps will be taken to organize the Bureau of Employment, which will perhaps bear the more dignified name of Bureau of Registration. Three distinct efforts will be put forth: (1) to secure from each member the records required, (2) to develop new fields of employment for agricultural graduates and (3) to interest every prospective employer in the new Bureau. This is going to take considerable time and

* Student membership is limited to those who are senior students pursuing a degree course at an agricultural college.

there is no intention of opening the Bureau as an active institution until adequate interest has been created and a sufficient number of members have registered.

The Chilean Nitrate Educational Bureau of Toronto has generously offered to donate the sum of $1,000 to the Society during the year 1926, to cover the cost of any clerical assistance which may be necessary in the organization of the Bureau of Registration. This donation takes the place of the Chilean Nitrate Scholarship which was given last year to the Society and awarded to Mr. G. A. Scott. The Scholarship was $600.00 and the increased grant and the change in its purpose are expected to benefit the Society as a whole rather than an individual member. The new offer is now before the Dominion Executive Committee and undoubtedly will be accepted.

One of the reasons why the C.S.T.A. Bureau of Records, proposed by President Reynolds at the 1921 Convention and instituted in 1922, did not function as an Employment Bureau, was the financial impossibility of employing clerical assistance. The Bureau of Records ceased to function after the publication of the C.S.T.A. "Who's Who" in April, 1924. There is no apparent reason why the new Bureau of Registration should not become a permanent Society activity and be of increasing service as time goes on. Immediate results are not anticipated but if the members' records are kept up to date and educational publicity is not allowed to flag, the Bureau should soon be a recognized institution in Canada.

NOTES

The General Secretary addressed a meeting of the Faculty and Senior students of the Ontario Agricultural College at Guelph on December 10th. He dealt briefly with some of the obstacles which the Society has had to overcome since its oraganization in 1920 and outlined the purpose and operating methods of the proposed Bureau of Registration. The meeting was also attended by Mr. B. Leslie Emslie, Canadian Delegate of the Chilean Nitrate Educational Bureau, who is President of the Western Ontario local.

At the monthly meeting of the Montrea Branch on December 19th, the members were addressed by Mr. Henri Lefèvre, Director o the French Potash Society at New York.

The new branch at Ste. Anne de la Poca tière held its second meeting on Decembe 19th. The speaker was Dr. Auguste Pépin Dominion Seed Analyst at Quebec.

The Eastern Ontario local will hold its next monthly luncheon at Ottawa on January 8th and will be addressed by Mr. R. S. Duncan, Director of Agricultural Representatives in the Ontario Department of Agriculture His subject will be "The Boy and the Girl in Agriculture".

On the same evening (January 8th) an informal dance and bridge will be held at the Racquet Court, Ottawa, by this local.

At the annual meeting of the American Society of Agronomy, held in Chicago on November 16 and 17, twelve of the leading American agronomists were awarded Fellowships. One of those who was honoured in this way was Dr. C. A. Zavitz of the Ontario Agricultural College.

F. J. Greaney (O.A.C. '22) is taking graduate work in plant pathology at the University of Minnesota.

The present address of J. R. Weston (Manitoba '13) is Box 638, Red Deer, Alberta.

J. H. McCulloch (O.A.C. '16) is now on the advertising staff of the MacLean Publishing Company, Toronto.

G. C. Chamberlain (O.A.C. '22) is taking graduate work in Botany at the University of Toronto. His address is 103 St. George St., Toronto.

We have learned with deep regret of the recent death of J. E. Pintal (Laval '17). Mr. Pintal was a Charter Member of the Society, having joined in May, 1920. For further particulars see the French section of this issue.

MEMBERSHIP FEES

In fairness to those who are paying their membership fees promptly, it is intended to omit from the published list of members the names of any who are seriously in arrears. This list will be published at the end of January. Members who have not paid their fees for the current year should do so now, either to their local secretary or direct to the General Secretary.

Some Phases of the Inorganic Nutrition of Plants in Relation to the Soil Solution.

2. Soil Solutions as Media for Plant Growth.

D. R. HOAGLAND

Laboratory of Plant Nutrition, University of California.

According to the best supported views, plants withdraw from the soil the various essential or non-essential elements directly through the medium of the soil moisture. The growth of plants in solution cultures proves that the solid phase is not indispensable *per se.* Our problem then is to determine the chemical composition of the soil solution in its relation on the one hand to the soil mass and on the other to the plants growing in the soil. Clearly, this is the basic inquiry underlying the maintenance of soil fertility, the use of fertilizers, and soil management in general. The great obstacle to research in this field has been the difficulty of separating soil solutions from the soil mass, so that they could be analyzed chemically. A number of methods have been proposed with this end in view, but in every case serious practical or theoretical objections have been raised. Only in recent years has some measureable progress been made.

In the earlier work of the California laboratories, recourse was had to the expedient of water extracts (2-27). These investigations were begun ten years ago by assembling in Berkeley considerable quantities of thirteen different soils from various parts of the state. These included six silty clay loams of the same series and seven fine sandy loams of different series. A considerable variety of crop histories and climatic conditions was represented. The soils after very careful mixing were placed in duplicate tanks, each holding about a ton of soil. After the first year, one set of soils was cropped annually with barley while the other set was kept uncropped. Drainage was prevented and the desired moisture conditions were maintained by the use of distilled water. During the first few years, samples of the various soils were taken at frequent intervals during the growth of the crop and also at a number of periods during the remainder of the year. All of these samples were extracted with water in the proportion of one part of soil to five parts of water and the extracts were analyzed for the most important chemical elements. A great mass of data was obtained in this manner, and its significance can best be appreciated by reference to some of the typical graphs. (Fig. 5, 6, 7).

The first point which strikes the attention is the fluctuating character of the soil solution in so far as the latter is reflected in the water extracts. Both the cropped and uncropped soils displayed these fluctuations, but the influence of crop growth is manifest. There was a general tendency toward a diminished concentration in the soil solution at the height of crop growth and nitrate, in fact, almost disappeared. That these effects were not accidental is indicated by the good agreement between the data for the duplicate soils in the first year of the experiment when all the soils were cropped. If the graphs for two soils of low or medium and high production be compared, it will be observed that at the beginning of the season, the average concentration of solutes in the soil solution was higher in the more productive soils, and that these soils, when kept in an uncropped condition, possessed a marked ability to develop during the season high concentrations of solutes, thus indicating a greater supplying power for essential elements. It should be noted especially that at the height of crop growth, soils of different production could not, in general, be distinguished by their water soluble matter, since there was a tendency toward the production of low concentrations of very similar magnitude in all the soils examined.*

* Certain very fertile soils, high in organic matter may maintain fair concentrations of NO_3 even at the height of crop growth, as shown by F. W. Wyatt.

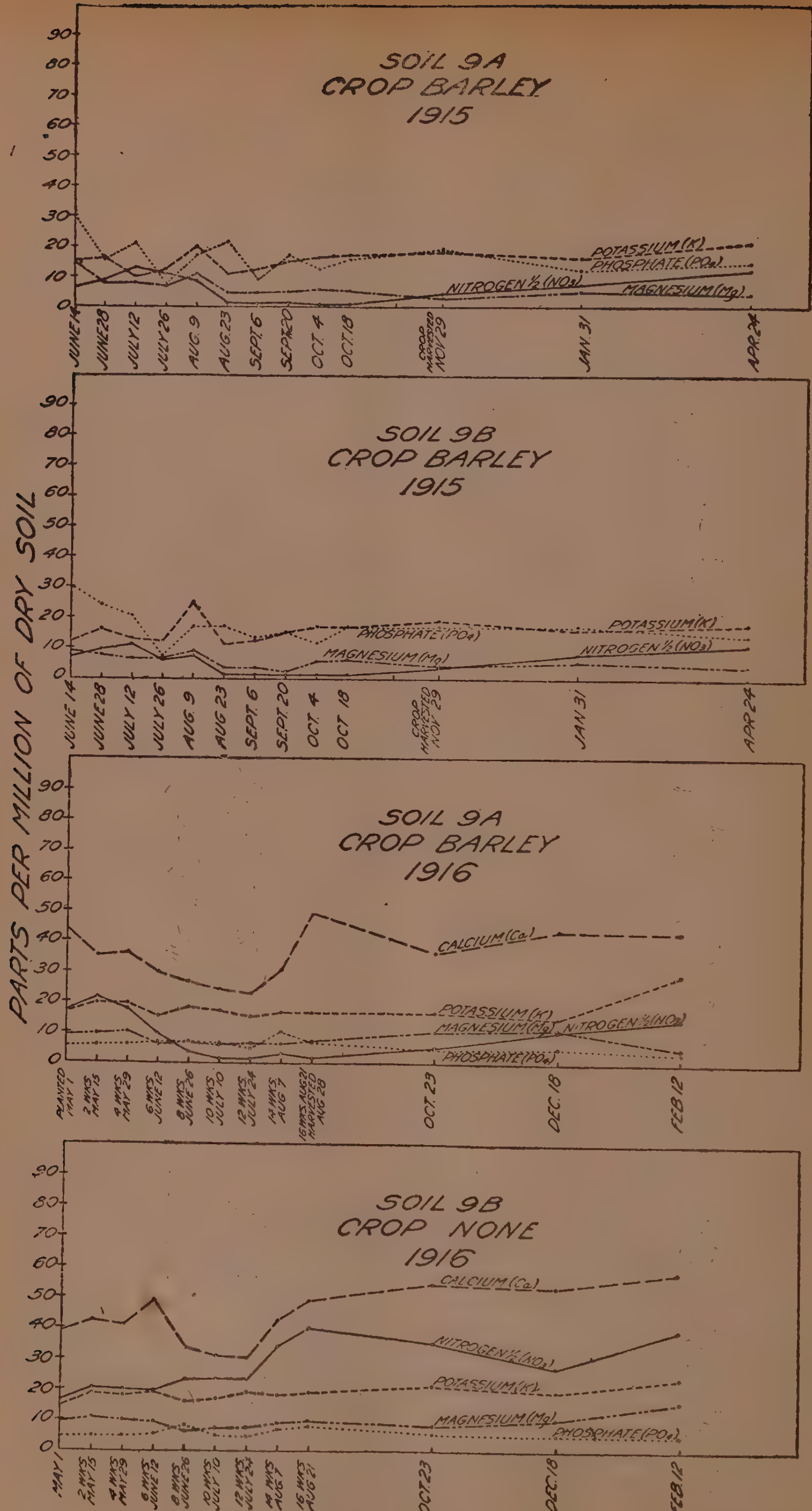

FIGURE 5

From G. R. Stewart, Jour. Agr. Res., Vol. XII, No. 6, 1918.

Seasonal fluctuations in water soluble constituents of fine sandy loam (No. 9) soil yielding 946 grams total dry matter for container.

Displacement Method for Obtaining Soil Solutions

Before proceeding to elaborate upon the theme which I have introduced, I should like to describe some of the most recent researches in which another method for studying soil solutions has been employed. It appears that water extracts do reflect the true soil solution in a general way and in certain soils perhaps very closely if the smallest possible proportion of water to soil is selected in making the extracts (15), but obviously it is far more convincing to study solutions obtained from soils at optimum or lower moisture contents without any dilution. Pressure methods such as the oil pressure method and the Lipman high pressure method can be used, but the technical difficulties are great if many soils must be examined at frequent intervals. Fortunately, another method, that of water displacement, has proved exceedingly valuable. This is a very old method in principle, but was recently introduced in modern form by Parker (22) and later modified and extensively and critically studied by my colleagues, Professor Burd and Mr. Martin (1). By their technique, it is possible to obtain in a short space of time (from soils of the lighter type) solutions at soil moisture contents most interesting to investigate. The description of the method has recently been published and it would take too long to repeat it here.

Some of the soils already described have been examined according to the displacement method by Burd and Martin (3), and very interesting comparisons are now available of the soil solutions obtained from different lots of the same originally homogenous masses of soil, held under different conditions for eight years (cropped, uncropped, and stored in air-dry state).

Before entering on the discussion of the results obtained through the use of the displacement method, it will be desirable to have in mind the changes in crop production which have taken place during eight years in those soils which have been continuously cropped, recalling that moisture conditions were equally favorable each year and that seasonal environments were fairly uniform from year to year. In every instance a marked decrease in production has occurred and the indications are that relatively low levels have been reached which might be maintained for many years. (Table 5).

TABLE 5

Yields of Grain and Straw from Soils Continuously Cropped to Barley.

Averages of thirteen characteristic California Soils

Year	Grain lbs. per Acre	Straw lbs. per Acre	Grain and Straw lbs. per acre
1915	4,215	8,175	12,390
1916	4,405	6,075	10.480
1917	4,000	5,305	9,305
1918	2,445	3,390	5,835
1919	3,435	3,930	7,365
1920	2,670	2,445	5,115
1921	2,370	2,505	4,875
1922	1,600	1,830	3,430
1923	1,615	2,145	3,760
1924	1,890	2,345	4,235

The soils are kept in containers from which there is no possibility of leaching. Distilled water is added when necessary to maintain each soil at its optimum moisture content during the growth of the crop. All soils are subject to the same climatic conditions, which are fairly uniform from year to year.

For our present purpose, it can be assumed that the soils stored in the air dried condition are representative of the potentialities of these soils at the beginning of the experiment. The observations on the cropped and uncropped soils were made in the spring before planting at a time when maximum concentrations of solutes would be developed in the soil solutions. The moisture contents of the different soils were all brought close to the optimum before displacing the soil solutions and were sufficiently similar to make direct comparisons possible. The data have also been computed to the basis of uniform moisture contents for each soil.

Effect of Cropping on Soil Solution

The data on the composition of the soil solutions as presented in the table are of exceptional interest because of the definite control which has been exercised over these

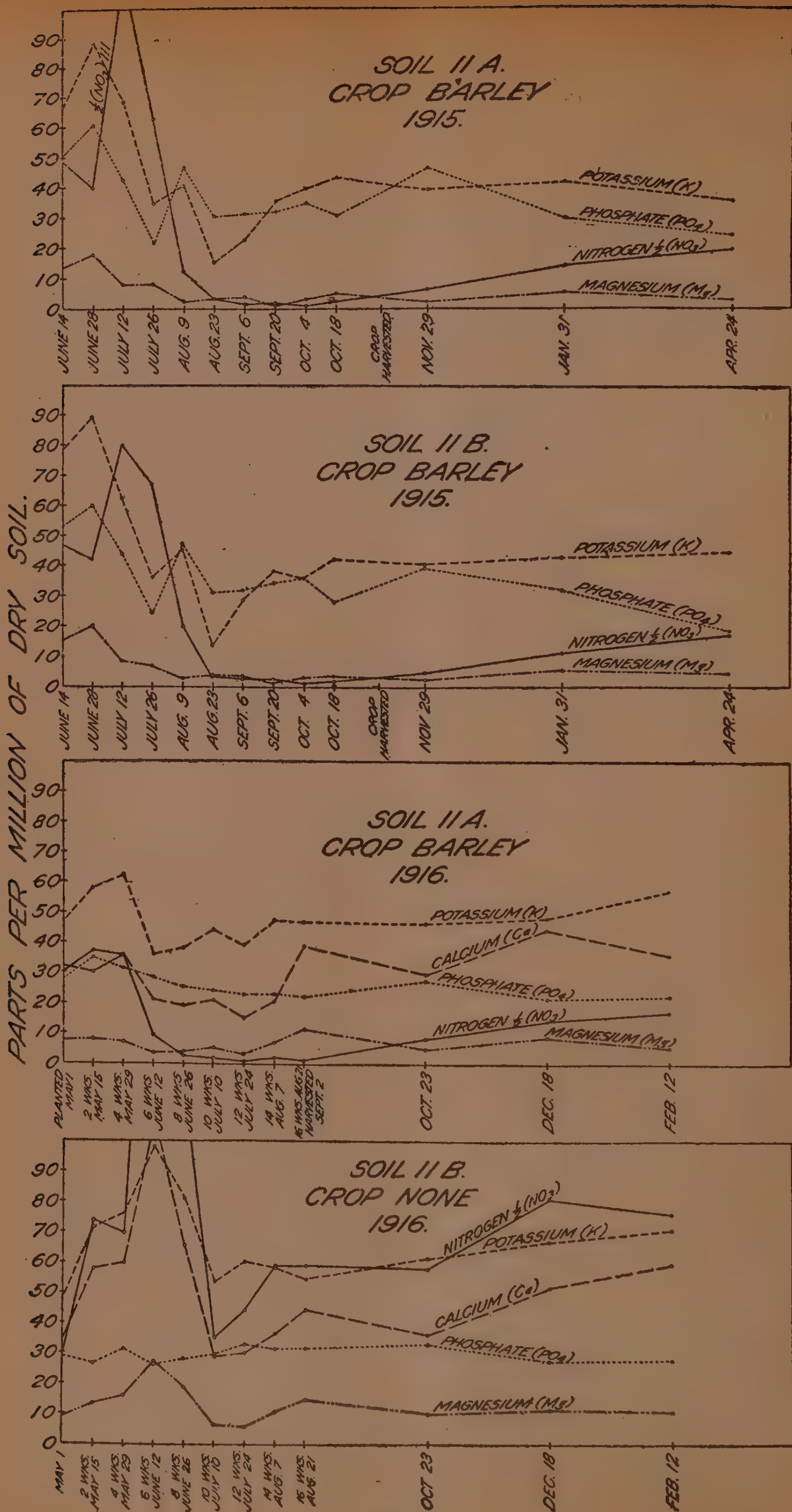

FIGURE 6

From G. R. Stewart. Jour. Agr. Res., Vol. XII, No. 6, 1918.

Seasonal fluctuations in water soluble constituents of fine sandy loam soil (No. 11) yielding 1547 grams total dry matter for container.

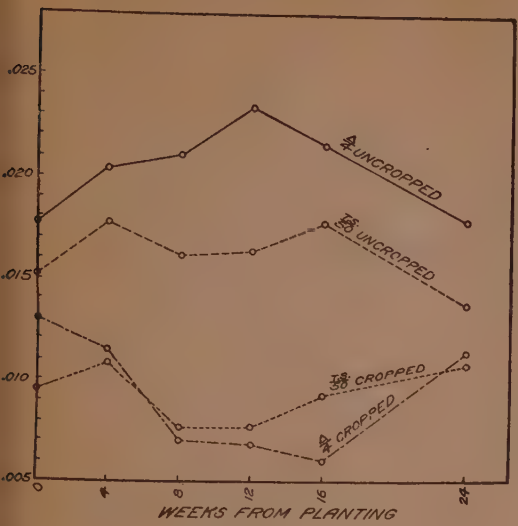

FIGURE 7

rom Hoagland, Martin and Stewart, Jour. Agr. Res., Vol. XX, No. 5, 1920.

Solutes in cropped and uncropped soils at dif-rent times during the growing season, as shown water extracts (total solids) and freezing point pressions. Averages of six soils.

ils for the eight year period. (Table 6) We st observe that the total concentrations of lutes were strikingly decreased as a result cropping. No leaching took place at any me. The ability of the soils to develop trate has been very greatly curtailed, and ith a few exceptions, the concentrations of e cations have also been significantly de-eased. Of the anions, Cl has apparently en completely removed from the soil as a sult of cropping. The phosphate has suf-red a reduction of concentration of very rge proportions in most of the soils. On e contrary, sulphate has increased in con-ntration in several cases being higher in e cropped soils than in either the stored or cropped soils. In five soils, the sulphate ncentrations are higher in the uncropped ils than in the stored soils. With regard the concentrations of other ions in the cropped soils, these, with the exception of osphate have, in general, been enhanced by e treatment.*

The uncropped soils were kept moist with dis-tilled water for several years and since then have not been irrigated nor subjected to rainfall.

us consider further the seasonal changes af-fecting the composition of the soil solutions of the cropped soils. (Table 7). In practically every soil, all the ions except bicarbonate were very materially lower in concentration in September than in April before the crop was planted. By the following April, in most soils the concentrations have been re-stored to approximately the values obtaining during the preceding spring. These data on soil solutions by the displacement method are available only on samples taken after eight years of cropping when the soils had ap-parently reached a fairly low and constant level of production. The results previously referred to show that before this period was reached, cropping had significantly reduced the potentialities of the soils for producing high levels of solutes in the soil solution.

We are now ready to suggest a few gen-eral deductions on the basis of the results ob-tained from soil experiments, and also from the artificial culture experiments described in the first lecture. In the first place, I think it is justifiable to state with some confidence that there is no necessarily fundamental dis-tinction between artificial culture solutions and soil solutions. It is true that in one res-pect, artificial solutions as ordinarily employ-ed present a point of difference. As we have seen, even in a soil of good production, the phosphate concentration may be very low, while the initial concentration of phosphate in artificial solutions is likely to be relative-ly high. This, however, is only a matter of convenience. We have grown excellent plants in artificial culture solutions in which the concentrations of phosphate were as low as in the soil solutions which have been ex-amined. (14) Under both conditions, the im-portant point is that a minimum concentration should be maintained, the solutions being re-plenished as absorption by the plant takes place.

Ability of Soil to Supply Essential Elements to the Plant

This idea now brings us to a consideration of the most important concept of all in the relation of plant growth to the soil solution. To express this concept, it will be convenient to adopt the term "supplying power" to bor-row a phrase used by Livingstone (18) in another connection. The vital question is:

TABLE 6

Displaced solutions from cropped (A), fallowed (B), and air-dry stored (S) soils after eight years.

(Results calculated to a uniform moisture basis for each soil)
From J. S. Burd and J. C. Martin, Soil Science, Vol. XVII, No. 2, 1924.

			Parts per Million of Displaced Solutions										
Soil	Moisture	pH	NO_3	HCO_3*	Cl	SO_4	PO_4*	SiO_3	Ca	Mg	Na	K	Total
	per cent												
7A		7.4	116	83	0	438	1.1	—	189	71	33	16	947
7B	16	7.6	1781	73	55	454	1.2	—	672	134	75	38	3281
7S		7.2	1468	69	313	184	3.3	38	547	112	123	39	2896
8A		7.4	179	93	0	413	2.5	—	174	61	20	13	955
8B	14.7	7.0	1798	59	41	445	4.0	—	590	160	68	77	3242
8S		6.9	2182	77	260	451	7.2	61	539	204	156	156	4093
9A		7.6	121	73	0	270	0.9	—	161	57	20	9	750
9B	15.1	7.6	966	63	37	428	1.2	—	469	95	54	30	2144
9S		7.3	680	46	372	184	2.9	33	380	75	88	21	1882
10A		7.2	173	40	0	270	1.2	—	140	109	17	25	775
10B	18.5	7.0	1658	34	31	339	2.1	—	532	132	46	72	2846
10S		6.8	937	34	348	148	4.0	51	360	91	115	89	2173
11A		8.2	138	160	0	537	3.3	—	177	77	70	32	1200
11B†	15.5												
11S		7.8	1049	171	367	344	12.1	49	407	128	203	100	2830
12A		7.3	92	40	0	225	2.3	—	96	37	22	10	524
12B	15.1	7.0	1473	34	39	330	0.3	—	573	148	59	44	2701
12S		7.3	208	39	80	170	3.1	48	145	48	52	30	823
14A		8.0	142	107	0	287	1.3	—	136	46	54	44	817
14B	18.5	7.4	1709	54	58	384	1.7	—	529	135	82	114	3069
14S		7.4	779	78	100	188	4.3	54	290	91	74	89	1747

*Bicarbonate and phosphate remain as in Table (see text.)
†Soil not available for study.

Composition of soil solutions of fine sandy loam soils, subjected to different conditions. Samples taken in spring. Soil solutions obtained by the displacement method at approximately optimum moisture contents.

Can the soil supply to the plant, through the medium of the soil moisture, in each unit of time, the necessary amounts of all essential elements? Now hypothetically, we might fulfill this condition if at the beginning of the season sufficient quantities of solutes for the entire growth cycle of the plant were present in the total mass of soil becoming accessible to the plant during the season. Such a condition is actually realized in certain types of sand cultures, but in a soil the plant will normally depend not only upon the solutes present at the beginning of its growth cycle, but also upon the solutes formed concurrently with plant growth. Thus the absorption of phosphate by the plant will disturb that pa ticular equilibrium and more phosphate, d rived from the solid phase, will enter int solution. Nitrification may occur and ad to the supply of nitrogen and other element

From the solution culture experiments, was learned that very low concentrations c solutes might suffice for plant growth, provi ed measures were taken to prevent the a sorption by the plant from lowering the concentrations below critical points. Th general order of magnitude of concentratio in media suited to plant growth seems t be very similar for both soil solutions an artificial solutions, but undoubtedly the i

TABLE 7

Solutions displaced from cropped (A) soils at beginning and at the end of the growing season (1923) and at the beginning of the next growing season (1924)

From J. S. Burd and J. C. Martin, Soil Science, Vol. XVIII, No. 2, 1924.

Soil Number	Date	Moisture	pH	Parts per Million of Displaced Solutions							
				NO_3	HCO_3	SO_4	PO_4	Ca	Mg	Na	K
		per cent									
	Apr. 30, 1923	10.7	7.4	174	83	655	1.1	283	106	49	24
7	Sept. 4, 1923	12.5	7.6	58	155	432	0.6	193	47	40	9
	Apr. 28, 1924	14.2	7.6	222	142	571	0.6	296	67	52	11
	Apr. 30, 1923	9.6	7.4	274	93	633	2.5	267	93	31	20
8	Sept. 4, 1923	8.4	7.6	88	143	275	1.4	153	56	28	11
	Apr. 28, 1924	13.2	7.2	227	107	441	2.1	232	78	23	10
	Apr. 30, 1923	11.4	7.6	160	73	432	0.9	213	75	27	12
9	Sept. 4, 1923	13.8	7.8	43	167	121	0.3	107	32	30	7
	Apr. 28, 1924	12.9	7.6	182	98	390	0.5	220	57	28	10
	Apr. 30, 1923	13.9	7.2	230	40	360	1.2	187	145	23	33
10	Sept. 4, 1923	14.4	7.6	40	112	241	0.7	108	38	16	23
	Apr. 28, 1924	16.0	7.2	200	73	423	1.1	216	70	17	25
	Apr. 30, 1923	12.9	8.2	166	160	645	3.3	213	93	84	39
11	Sept. 4, 1923	12.4	7.6	16	234	598	1.2	192	64	44	22
	Apr. 28, 1924	11.4	8.1	286	259	854	2.9	300	102	85	38
	Apr. 30, 1923	12.1	7.3	115	40	281	2.3	120	46	27	13
12	Sept. 4, 1923	13.5	7.6	50	68	184	0.7	80	28	12	9
	Apr. 28, 1924	13.7	7.3	156	49	313	0.7	156	50	18	10
	Apr. 30, 1923	18.0	8.0	146	107	295	1.3	140	47	56	45
14	Sept. 4, 1923	18.7	7.6	13	176	174	0.2	80	23	26	23
	Apr. 28, 1924	18.8	7.6	167	142	380	1.0	168	55	47	49

Soil solutions of soils at different times of year. Soils had been cropped (barley) continuously for 9 years.

luence of the solid phase cannot be neglected. In a solution culture, diffusion will take place very rapidly, but in a solid medium there must be great retardation of diffusion. This is indicated by some of the data we have secured for the purpose of comparing absorption from solution cultures and sand cultures when the same amounts of solution were employed in both types of cultures. The plants grown in the solution cultures absorbed greater quantities of nearly all elements, although root development and presumably total absorbing surface, was greater in extent in the sand cultures. In the soil, the effect of the solid medium on diffusion would probably be still greater, so it is not possible to make any exact estimate of the critical concentrations of ions for soil solutions, which concentrations would vary, furthermore, with each soil, type of plants and stage of growth. Probably in general, both the minimum and maximum concentration would be higher in soil solutions than in culture solutions in the absence of a solid medium.

Physiological Interpretation of Data on the Soil Solution

One of the great difficulties with which we are faced in interpreting data on soil solutions is that a solution obtained from a soil by displacement or other means represents an average of a mass of soil and is not necessarily identical with the solution in contact with the absorbing root membranes of the plant. In fact, it is highly improbable that

any uniform condition exists throughout any considerable mass of soil. Absorbing root membranes function only for a limited period and presumably absorption at any given time is much more active in some zones than in others. In some localized areas, maximum depletion may have occurred while in others the higher concentrations are still maintained. Particularly in regard to hydrogen ion concentration, it is difficult to say what is the physiologically effective pH value of the soil solution. Actively absorbing roots excrete large amounts of CO_2 which, in certain systems, must have a tendency to reduce alkalinity. If the soil normally has an acid reaction, the growth of the plant and the consequent production of bicarbonates in the culture medium will tend to decrease acidity in the immediate neighborhood of active root surfaces. If the soil is to exert its characteristic reaction on the root system, solution and diffusion processes must keep pace with the metabolic processes of the plant and it is not certain that this would always be the case.

Another complication which must be met is the effect of changes in moisture content on the concentration of various ions in the soil solution. In highly controlled experiments, moisture contents may be maintained approximately at the optima, but in the field, they will usually fluctuate and the data secured by Burd and Martin (1) show that some ions may increase their concentrations almost proportionately to the decrease in moisture content within certain ranges.

Physiologically, the problem is very intricate indeed, since changes in concentration in the soil cannot bear any simple relation to the nutrition of the plant even in solution cultures, as we have already seen. In the soil, the ability to supply water to the plant at lower moisture contents, the influence of the moisture content on diffusion processes, and other questions must all enter into any attempted interpretation of physiological effects.

Notwithstanding the manifold difficulties of determining or deducing the composition of the physiologically effective soil solution, still we have every reason to believe that it is possible to determine the general nature of soil solutions influencing plant growt and to utilize data actually obtainable in ma ing valuable correlations between the d solved matter of the soil and plant growt Differences in soil solution conditions su ficiently great to have an important influen on crop production are likely to be reflect in the results of water extraction or soil sol tion procedures.

Microbiological Processes and the Soil Solution

So far in our discussion, soil solution pro lems have never considered with reference the higher plants, but there is another biolog cal phase of the general problem which ve obviously demands attention. It is universa ly conceded that microorganisms play an i dispensable role in the maintenance of so fertility, and a very large number of studi on soil microorganisms of various types a on record. It appears, however, that t time has arrived for intensive investigatio of the relations existing between the so organisms and soil solutions. We must r cognize that the activities of these organisn govern, in large measure, the concentrati and composition of such solutions. If a so is thoroughly leached with water, it is po sible to reduce the concentration of its sol tion to a very low level. On standing, add tional material may enter into solution, b the building up of a soil solution adequa for crop growth is dependent upon the fo mation of anions as a result of the metabo ism of soil bacteria or other organisn Nearly all the anion content of a soil sol tion (HCO_3, SO_4, NO_3) is derived in th way, and, of course, equivalent quantities cations must enter into solution at the sar time. Therefore from the point of view modern soil solution theories, the empha long given to the necessity of providing su able environments for desirable microorga isms is entirely justified. Nitrification, sulf fication and production of carbon dioxide a usually the determining processes in the fo mation of soil solutions. Emphasis on t importance of microbiological processes connection with soil solutions obviously i plies an equal emphasis on the role of orga matter in soils.

While biological processes are concern with the bringing of bases into solution, t

particular types of bases will depend upon the solid phase of the soil and particularly upon those colloidal constituents involved in the replacement of bases. It is a very important matter whether or not too great a proportion of calcium and magnesium has been replaced by sodium, hydrogen or trivalent bases.

It is fortunate that a great deal of valuable investigational work has been reported dealing with the replaceable bases of the soil. European investigators have had this question under examination for a long time, while more recently Kelley (16) and his colleagues have carried on various intensive chemical studies in this field. Although many problems still remain to be solved, yet a number of extremely important phases of soil chemistry have been very appreciably clarified by the work already completed. The significance of the stoichiometrical exchange of bases is now evident in two, at first thought, widely different types of soil conditions, represented by acid soils and by highly alkaline soils.

Soil Acidity and Plant Growth

There is perhaps, no aspect of soil chemistry which has attracted so much attention as soil acidity. A definite advance has been made in the attempts to measure by a physical chemical method the hydrogen ion concentrations of soil solutions, but it is possible that enthusiasm in this direction may sometimes interfere with the due appreciation of the many factors affecting plant growth which are not expressed by the hydrogen ion concentration, or are not related to this value in any simple way.

The low calcium content of the soil solution may be a limiting condition in some acid soils, entirely aside from the degree of acidity. Through the operations of the natural processes which result in an acid reaction, calcium may have been displaced to a greater or lesser extent from the reactive silicate compounds by hydrogen, and as a consequence the concentrations of calcium in the soil solution or the soil's supplying power for this element may become inadequate for crop growth. In an artificial culture solution, an equal intensity of acidity might be maintained, but with an adequate concentration of calcium, the unfavorable condition of the acid soil might not be duplicated. The addition of lime to the soil would not only decrease the hydrogen ion concentration but also bring into the soil solution a greater concentration of calcium. Of course, calcium deficiency is not the only possible reason for inhibited growth in acid soils. A good deal of support has been given to the idea that aluminum may often be present in acid soil solutions in toxic concentrations. Other toxic substances might also occur, and finally the concentration of hydrogen ions might sometimes be so great as to become toxic *per se.*

The point I especially desire to emphasize is that a great opportunity exists for analyzing the physiological environment of acid soils by systematic studies of soil solutions through the use of methods already described. Definite advances may reasonably be expected if various types of acid soils be investigated, not merely with reference to hydrogen ion concentrations or to some empirical lime requirement method, but also with reference to concentrations of all the important ions of the soil solution, including iron, aluminum and manganese. In such experiments, the seasonal changes in soil solutions should not be neglected. Concurrently, with the chemical studies, observations on the soil microorganisms should be made. So far as I am aware, no complete study of an acid soil has yet been made, meaning by "complete", simply the application of methods definitely available at the present time. Researches of this type would require cooperative effort and would be expensive, but they are entirely within the range of possibilities and would provide a kind of information which cannot be gained by restricting the work to determinations of lime requirements or to field tests.

Alkaline Soils and Soil Solutions

It is not my purpose to attempt anything in the nature of a discussion of alkali soil conditions, which subject in itself would require a series of lectures, but it is worth while to note that the general methods of attack are not essentially different from those indicated for any other soil investigations. In certain highly alkaline soils, as Kelley (16) and others have shown, the silicates involved in the replacement of bases provide a fertile

field for study. The extensive replacement of divalent bases by sodium brings about both physically and chemically, a condition which renders the soil unfit for the growth of useful plants. The soil solution, under these circumstances, may become not only too alkaline because of the hydrolysis of sodium compounds, but also may not be capable of maintaining a sufficient concentration of calcium, or other essential ions. If the soil be saline, again we find it necessary to interpret our data in terms of the soil solution for the purpose of understanding how the crop is injured, or in order to make comparisons with the results obtained from solution culture experiments.

Relation of Soil Solution to Physical State

Possibly it may seem that in giving so much time to the consideration of the nature of soil solutions, I have, at least by inference, not assigned sufficient importance to the physical state of soils in its relation to crop production. Detailed discussion of this subject is, of course, outside the province of this lecture, yet it is well to bear in mind how closely interwoven are the phenomena of the soil solution and those of the physical state of the soil. Fluctuations in the chemical composition of the soil solution cannot change the general physical texture of a soil, but the soil solution does have a pronounced influence on the behavior of the soil colloids. It has been shown (13) that the depletion of soil solutions by crop growth may be reflected in certain physical characteristics of the soil. An incidental illustration of this has been noted by Martin in preparing soil solutions from samples of the same soil obtained at different periods of the year. Using exactly the same technique, it was found that the displacement of the soil solution proceeded much more readily when the samples were taken in the spring than when they were taken after eight or ten weeks of growth of barley plants. In earlier studies, similar relations were brought out in comparing the amounts of material remaining in suspension, using samples of soil taken at different times of the year. (Fig. 8).

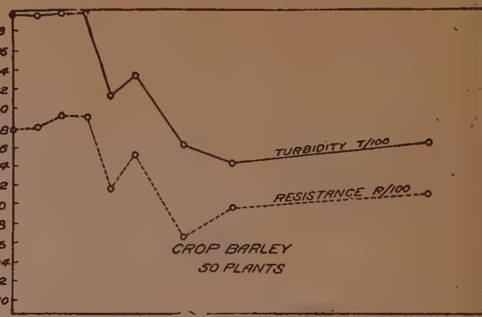

FIGURE 8

From Hoagland and Martin, Jour. Agr. Res., Vol. XX, No. 5, 1920.

Showing increase of suspended matter in soil suspensions accompanying decreased concentration of water extracts as result of crop growth. Concentrations of solutes indicated by electrical resistance.

In many ways, the physical constitution of the soil is related to plant growth, through the soil solution. The physical state of the soil as affecting aeration may determine, in part, the types of microorganisms which can thrive and thus influence the soil solution in the manner already suggested. The total amount of soil solution accessible to a plant will depend upon the development of absorbing root surfaces, and this, in turn is greatly modified by varying the physical condition of the soil.

General Remarks and Conclusions

In all my previous remarks, I have been attempting to outline the results and methods by which scientific understanding of the relation of plant growth to the soil moisture might be built up. Perhaps it will be expected that I should offer some comments on the possible practical applications of the scientific findings. I should first like to mention the negative side, which is not without practical importance. If the dynamic view of soils and plants be correct, if the whole system be indeed one in which rates at which chemical processes proceed is of first importance, then we cannot expect to achieve anything of ultimate value in terms of plant growth by making conventional soil analyses. Furthermore, if it be true that the soil is a highly reactive medium, we cannot predict how the medium will be affected when soluble substances are added by a computation based simply on the amounts of such added substances. For this reason, and

also because the physiological questions are unsolved, it cannot be hoped that general recommendations of fertilizer needs for each different crop will meet with success. If it be granted that soil conditions and plant growth are intimately bound up with climatic conditions, then no exact statements can be made with regard to the effect of a given treatment for any particular season.

Referring to the positive side of the question, we must distinguish between empirical tests and scientific experiments. It seems probable that properly conducted local tests may often yield information of decided practical value for the particular localities where the tests were made, even though the scientific principles involved remain obscure. It is important in emphasizing the usefulness of empirical tests to emphasize likewise that they are not scientific experiments and are not a substitute therefor. During recent years, work has started on another method by which practical conclusions may be deduced and leads suggested for further investigation. This is the method of statistical study, which has, however, as Russell points out, a requirement not ordinarily capable of fulfillment, namely, the availability of great numbers of careful observations made over long periods, such as have been obtained at the Rothamsted Station.

Neither the method of empirical test, nor that of statistical study, are capable of furnishing answers to all, even of the purely practical questions relating to soil management. This statement is particularly applicable to arid regions where malnutrition difficulties are numerous and where it is imperative that an understanding should be gained not only of the immediate effects of soil treatments, but of the ultimate consequences of such treatments extending far into the future.

Scientific research on soils and plants must place great reliance on the results of experiments conducted in the laboratory or greenhouse. The objection often raised to such investigations is that they are artificial and do not imitate field conditions. This is very properly the case, otherwise the requisite control would be absent. There can be nothing mysterious about field conditions. They are simply more variable and uncontrolled than soil cultures conducted in pots or tanks. However, it is not at all unlikely that soil solution studies could now be extended to soils under field conditions with considerable advantage, if appropriate resources were available. Of course, no one would suggest that it would be worth while to take haphazard samples from the field at some one time of the year and make examinations of the solutions prepared from these samples. It may be suggested that the procedure should be rather to select small areas where certain particularly interesting crop responses are evident and then to sample such areas systematically and at different seasons. The data should be extensive enough to permit statistical evaluation. Experiments of this type would be most laborious, but there would be an opportunity at least in a certain proportion of the experiments, to determine facts and principles of permanent value. The more one considers the nature of soil and plant experiments, the more convinced he is that exact chemical control is indispensable and that this means large expenditures for highly skilled analytical chemists, although of course this is only one of the requirements. Individual researches by organic and physical chemists must continue to supply new ideas, new methods and new data on the organic constituents of plants and on the colloids of the soil.

In closing, I should like to make use of two quotations expressing far better than I could do, the general nature of agricultural research, which quotations apply also to the researches which I have described in these lectures. One quotation from Sir Daniel Hall (8) states the extreme complexity of the problems and the difficulties of practical applications, and the other from Sir John Russell (26) brings out the idea that practice is not the sole aim of research in agriculture, any more than in other fields of knowledge.

The first quotation is:

"Great are the achievements and still greater the possibilities of agricultural research, but we must recognize that there are limitations to the effect of science upon agriculture which do not hold for the other industries. In the first place, in agriculture we are dealing with a living organism and the amount

of control that we have obtained over plant or animal, over that stubborn essence we call life, is far less than we can exercise over inanimate nature, over iron or cement, over even the ether or the atom. When we attack vital problems we find that we can not speed up processes or enlarge the unit in the way we can deal with the dynamo or spinning frame. It still takes the wheat plant six or nine months to develop, and cows bring forth their calves neither more quickly nor more numerously for us than they did for Abraham. We see no way of growing three or four crops a year under temperate climatic conditions. The organisms we are dealing with will go through their cycle and you cannot hurry them. When you start hustling you find you let in secondary troubles of all sorts.

"These limitations lie in the nature of things, and though on looking back we can count up the immense advances that agriculture owes to the application of knowledge we must not hope for sudden development or revoluntionary changes such as have been seen in flying or wireless telegraphy."

The last quotation from Russell, is taken from the closing paragraphs of an address given before the British Association at Toronto and with which many of you are familiar:

> "And that leads to my last point. What is the purpose of it all? Team work, co-operation, the great expenditure of time and money now being incurred in agricultural science and experiment—these are justified only if the end is worthy of the effort. The nineteenth century took the view that agricultural science was justified only in so far as it was useful. This view we now believe to be too narrow. The practical purpose is of course essential; the station must help the farmer in his daily difficulties—which again necessitates co-operation, this time between the practical grower and the scientific worker. But history has shown that institutions and investigators that tie themselves down to purely practical problems do not get very far; all experience proves that the safest way of making advances, even for purely practical purposes, is to leave the investigator unfettered. Our declared aim at Rothamsted is 'to discover the principles underlying the great facts of agriculture and to put the knowledge thus gained into a form in which it can be used by teachers, experts, and farmers for the upraising of country life and the improvements of the standard of farming.
>
> "This wider purpose gives the investigator full latitude, and it justifies an investigation whether the results will be immediately useful or not—so long as they are trustworthy. For the upraising of country life necessitates a higher standard of education for the countryman; and education based on the wonderful book of Nature which lies open for all to read if they but could. How many farmers know anything about the remarkable structure of the soil they till, of its fascinating history, of the teeming population of living organisms that dwell in its dark recesses; of the wonderful wheel of life in which the plant takes up simple substances and in some mysterious way fashions them into foods for men and animals and packs them with energy drawn out of the sunlight—energy which enables us to move and work, to drive engines, motor-cars, and all the other complex agencies of modern civilization? No one knows much of these things; but if we knew more, and could tell it as it deserves to be told, we should have a story that would make the wildest romance of human imagination seem dull by comparison and would dispel for ever the illusion that the country is a dull place to live in. Agricultural science must be judged not only by its material achievements, but also by its success in revealing to the countryman something of the wonder and the mystery of the great open spaces in which he dwells."

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Improving Sunflowers by Inbreeding.

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Agrostologist, Central Experimental Farm, Ottawa.

The sunflower as a producer of succulent forage has increased in favour and importance in Canada during recent years. This is particularly true of those sections of the country where seasonal conditions are unfavourable for profitable corn growing. Because of this increasing importance of the crop in question serious consideration has been given to its improvement.

The use of inbreeding in the improvement of open fertilized crops has been well established. Even quite a few years ago it was looked on with favour but unfortunately all earlier publications concerning sunflowers classified this plant as self sterile. This, if true, would preclude inbreeding as a method of attack in its improvement.

In the year 1920 an extensive collection of sunflowers was made by the Forage Crop Division of the Central Experimental Farm at Ottawa, Canada. As the individuals in this collection began to head out it was noticed that there was a wide variation in plant type even within lots from seed of a common source and which had been subjected to mass selection for a period of years. So much more desirable were some of the types than others that it was decided to undertake the supposedly impossible and use inbreeding to try and isolate distinct true breeding strains. Several hundred heads of the more desirable individual plants were covered in 1920 and 1921 to prevent cross pollination. In a few instances an attempt was made to aid nature by intercrossing flowers on the individual heads but in most cases they were left unmolested. The majority of the isolated heads produced sufficient seed to plant short rows the following year.

In 1921 the germination of the seed from the heads isolated in 1920 was recorded very carefully. In most cases both germination and resulting stand of plants was as uniform and vigorous as that resulting from the seed of open fertilized plants.

Various materials and contrivances we tried to determine their relative efficiency mediums for the isolation of the individu heads. Among the materials tried were co ton and cheesecloth of various thickness an paper bags of several kinds. It was final decided that, taking everything into conside ation, a large manilla paper bag gave the be satisfaction. This type of bag has been use each year since 1921 with satisfactory r sults. The net coverings, unless the me was very close, allowed a high percentage intercrossing, while the paper bags prevent this entirely. The set of seed is of course n perfect under the paper bags, but from 15 50% of good seed is obtained and this quite sufficient to carry on the various strain

Where only a few plants are being work with, the set of seed may be very material increased by a small mechanical device f aiding in the scattering of the pollen on t enclosed head. This device consists of piece of wire to one end of which is attach a small piece of cotton. This is placed that the end with the attached piece of co ton is located directly over the opening flo ers. The other end of the wire protrud through the bag and serves as a handle manipulate the enclosed end. Every day t piece of cotton is rubbed lightly over t opening flowers by means of the device de scribed and increases the set of seed to marked degree. Where the number of hea being isolated runs up into the thousan such a method is of course much too tedio to be considered.

So far as branching is concerned the i bred strains secured may be roughly clas fied into the following classes:

1. Single stalk types
2. Branching types
   - A. Short branches and heads occu ring in the leaf axils of the ma stalk.

Branching type. Branches short and following up close to main stalk.

Iultibranching type. Very difficult to harvest.

Single stalk and head.

Single stalk and head. Dwarfed by inbreeding.

Single stålk and head. Foliage heavy.

Some types of Sunflowers obtained by 5 years selfing.

B. Branches growing parallel or nearly so to main stalk, lower branches longer than upper.

C. Branches widely spreading, with numerous secondary branches making harvesting difficult.

Within these general types there occurs a great variation in size of plant, shape and quantity of leaf and other morphological characters.

From an economic standpoint some of the branching types on which the branches grow parallel with the main stalk seem to be heavy yielders of leafy forage. Contrary to common belief the better multi-headed types also give more grain than the single headed sorts.

In general the results of the inbreeding approximate the findings in corn. The first three years resulted in a very marked increase in the uniformity of the strains concerned, and at the same time a corresponding reduc-
tion in size of the plants. Unlike the i
bred strains of corn, however, a number
the sunflower strains, while becoming extrem
ly uniform, did not lose any of their form
vigour. In fact some of the tallest, leafie
and highest yielding rows under test durin
the past years were strains that had been i
bred for five consecutive generations. The
retically it should be possible to combine i
to an inbred strain more desirable growt
factors than are possessed by the average
an open fertilized population. This poss
bility appears to be substantiated by ou
findings with inbred sunflower strains.

The more desirable of the inbred strai
are being intercrossed but to date there are in
sufficient data to enable one to draw definit
conclusions. Here again, however, the en
couraging results secured with corn are be
ing paralleled and the future of this wor
promises much.

WESTERN CANADIAN SOCIETY OF ANIMAL PRODUCTION

The Society named above was organized at Saskatoon at a Convention held on December 30 and 31, 1925. The first officers, who will hold office during 1926, are as follows:

Honorary Presidents: Hon. Geo. Hoadley, Hon. C. M. Hamilton, Hon. Albert Prefontaine. Honorary Vice-Presidents: Dr. H. M. Tory, Dr. Walter C. Murray, Dr. James A. MacLean.

President: Prof. J. P. Sackville, University of Alberta, Edmonton; Vice-President, Prof. A. M. Shaw, University of Saskatchewan, Saskatoon; Secretary Treasurer: Mr. L. T. Chapman, Dom. Experimental Station, Lacombe, Alta.

COMMITTEES:

On Methods of Investigation: W. H. Fairfield (chairman), L. M. Winter, M. J. Tinline, H. B. Sommerfeld, V. Matthews.

On Methods of Instruction: W. J. Rutherford (chairman), G. W. Wood, R. D. Sinclair, W. A. Munro, N. C. MacKay.

Special Committee (to investigate cause of soft pork and bacon alleged to come from Western Canada hogs): J. M. Brown (chairman), C. M. Learmonth, F. M. Baker.

RESOLUTIONS

1. Whereas it seems desirable that all live
stock experimental data on record at th
Agricultural Institutions in the three Prairi
Provinces be available to all the men connect
ed with Investigation, Instruction, Adminis
tration and Extension in animal production
in order that it may form a basis for futur
work.

Be It Therefore Resolved that this associa
tion recommend that those responsible for th
publishing of such results be asked to com
pile the information and submit same to th
executive of this society.

Be It Further Resolved that a copy of th
resolution be forwarded to the heads of th
various institutions conducting investigatio
work in animal husbandry.

2. Whereas we believe that the interest
of this association may be aided and further
ed by its affiliation with the C.S.T.A.

Therefore Be It Resolved that this associa
tion affiliate with the C.S.T.A., the terms o
the affiliation to preserve absolute autonom
for this association and such terms to be de
fined by the executives of the two associations

New and Unusual Diseases and Injuries of Tobacco.

C. M. SLAGG

Chief, Tobacco Division, Central Experimental Farm, Ottawa.

The Curly Dwarf Disease

The disease here described as Curly Dwarf was first observed in the summer of 1922 on a number of adjoining farms situated west of the village of Windsor Locks, Connecticut. It has been present on tobacco grown in this locality every year since. In August, 1925, it was also observed at Harrow, Ontario, and Albion Prairie, Wisconsin. The disease was brought to the attention of Dr. James Johnson in 1922, and he briefly mentions it in a recent publication (U.S. Dept. of Agr. Bulletin No. 1256) as a leaf malformation of which the cause is unknown.

In Connecticut, curly dwarf has been noted on Connecticut Broadleaf, Connecticut Havana, and Shade Cuban. At Harrow, Ontario, it was seen on the White Burley and Green River varieties. At Albion Prairie, Wisconsin, it was present on Connecticut Havana No. 38 and other cigar binder strains.

As far as known at present, this must be classed as a minor disease. Even in those fields worst affected, not more than 20 per cent of the plants showed disease symptoms. In only one locality, a district about two miles square near Windsor Locks, Connecticut, does it seems to assume economic importance. Here it has been more or less important each year since 1922. In other places where it has been observed, only an occasional plant shows the symptoms. In Connecticut, it appears more commonly and severely on the Broadleaf variety than on any other. In the district where it is most prevalent, experienced growers call these plants "Mongrels", and state that they have seen them in their tobacco fields for many years.

FIGURE 1.

A tobacco plant of the Connecticut Broadleaf variety affected with the Curly Dwarf disease. Note the recurved leaf edges and tips, and the rosetted appearance.

In appearance this disease is one of the most striking. The abnormal shape, size, and conformation of the leaves, and the dwarfed stature of the plant, make it conspicuous.

On plants badly affected (see Fig. 1) the leaves are distorted, wrinkled into folds on the surface, and the leaf edges and tips are sharply recurved downward and inward. An extreme shortening of the stalk, and of the leaf internodes, is seen. Sunken grayish brown to slate coloured lesions are found on the under surface of the leaf midribs and veins, and on the stalk. The entire plant appears as a rosette of wrinkled bulging leaves close to the ground. In this condition the leaves are extremely brittle.

A spotting of the upper surface of the leaves, and breakdown of the leaf tissues often occur, usually late in the progress of the disease. This spotting has some resemblance to the ring spot as described by Fromme and Wingard (Va. Agr. Exp. Sta. Technical Bulletin No. 25). In some cases it may be more noticeable than the leaf distortion.

The affected plants in a field always vary in severity of the symptoms exhibited, ranging from those plants so badly dwarfed as to reach only a few inches in height, to other plants of normal size, showing only a slight wrinkling and recurving of the upper leaves. Progressive symptoms occur only in the

younger leaves, so that a plant showing symptoms only in the upper leaves when half grown will, when full grown, show curly dwarf leaves only on its upper half. A few cases of apparent partial recovery have been observed, in which the upper leaves seemed less distorted than some lower down on the stalk, but usually there is no recovery and a plant showing curly dwarf when young becomes progressively worse, and as it grows, each succeeding leaf becomes more distorted and dwarfed.

It resembles the mosaic disease somewhat, in its distortion of the leaf, and the tendency in some cases for the upper leaves to exhibit leaf spotting and breakdown of the tissues. But it may always be distinguished from mosaic by the fact that there is never any variation in colour or thickness of the leaf web, by the characteristic vein, midrib, and stalk lesions, and by the extreme brittleness of the curled leaves.

Factors contributing to the occurrence of this disease are as yet unknown. The soil types on which it was observed were a sandy loam in Connecticut and Ontario, and Carrington silt loam in Wisconsin. Attempts to isolate a causal organism, and microscopic examinations of tissues from stem and stalk lesions, have been entirely negative to date. Inoculation experiments with macerated diseased tissues, with organisms isolated from infected leaves, and with aphids from curly dwarf plants, have been unsuccessful.

Irrigation Injury

In the past, tobacco has been most widely grown in humid districts where the rainfall was sufficient to supply the water necessary for plant growth. In the Okanagan Valley of British Columbia, however, tobacco has been grown for the past 35 years under irrigation. The precipitation here averages about 10 inches per annum, the Dominion Experimental Station at Summerland, B.C., reporting an average of 9,64 inches for the past five years, the majority of which falls outside the growing season. Irrigation is, therefore, relied on for agriculture in this fertile valley.

The Tobacco Division is conducting experimental work at several points in the Okanagan Valley, and during the 1925 growing season it was found necessary to irrigate some fields as many as five times. Cert[ain] portions of some of these fields at Summ[er]land, B.C., and Kelowna, B.C., due to s[...] topography, received an excessive amount [of] irrigation water. Tobacco plants growing [in] these areas showed characteristic injuries [n]ot present in other parts of the same field.

These injuries consisted of longitudina[l] oval, sunken, discolored areas on the stal[k,] one or more of which, when present, were [al]ways found at the base of each leaf, (see fi[g.] 2), at its point of attachment to the pla[nt] stalk. These lesions at the leaf base coales[...]

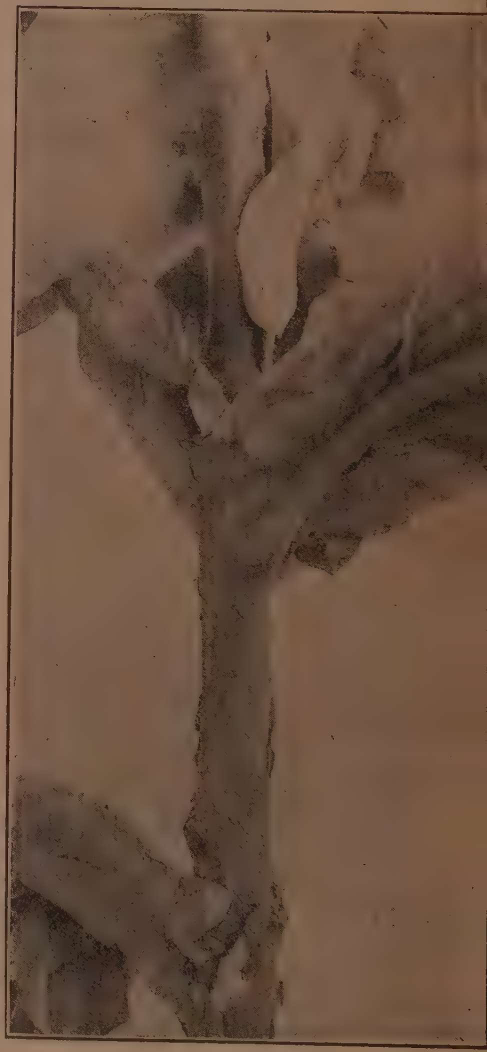

FIGURE 2.
Irrigation Injury to Tobacco. Note necrot[ic] areas on stalk and at base of leaves.

in the late stages to form an irregular, sunken, necrotic area below the point of leaf attachment. The leaf stem or midrib, on these plants, seems very brittle at this point, so that the green leaves snap off from the stalks very easily. In some cases the weight of the leaf itself seems sufficient to cause it to break off from the stalk. In one standing crop examined, the snap of breaking leaves could be distinctly heard here and there over the field. In handling badly affected plants at harvest, many leaves are lost, particularly from the lower half of the stalks. The injury seems always most severe on the basal part of the plant, diminishing in severity toward the upper leaves.

At the Summerland Station an additional injury in the form of frenching was also present in those parts of the field showing the stalk lesions and easily detached lower leaves. The frenching, however, could only be seen on the two or three uppermost leaves.

While realizing that definite proof is as yet lacking it is felt that an excess of irrigation water was to some degree responsible for the above described injury.

Stalk Borer Injury

During the summer of 1924 specimens of stalk borer injury to growing tobacco plants were collected in Rouville County, Quebec, and Essex County, Ontario. The injuries were identical, and the insect responsible was located in both cases pupating in the interior of the plant stem.

In an inspection of an infested field in Essex County, Ontario, about twenty plants were examined on August 22, 1924. These plants were all located in the first six rows on the edge of the field adjacent to a fence row overgrown with weeds and bushes.

The injury in every case was caused by a burrow excavated by the insect, in extent varying from one half to the entire length of the stalk. This burrow was in the pithy central portion of the stem, and was partially filled with waste material. Each burrow showed an apparent point of entry at the base of the plant near the ground, and an exit hole near the top of the excavation. At this time no larvae or adult insects were found. In most instances the burrows were empty, indicating that the larvae had pupated, and the adults emerged, prior to the date of examination. But in a few cases where the injuries appeared to be of more recent origin, live pupal cases were found in the burrows. One such live pupa is shown *in situ* in Fig. 3.

FIGURE 3.

Longitudinal section showing stalk borer injury to a tobacco plant caused by the borer *Papaipema nitela* Gn. Note the plug of waste material below and the exit hole above, both about equidistant from the pupal case in the burrow. Photographed Aug. 12, 1924, by M. B. Davis. Specimen from Rouville County, Quebec.

In dimensions the pupal cases varied from 50 to 60 mm. in width, and 185 to 250 mm. in length. The colour was brownish red. The larva appears to make an exit hole through to the outer air before pupating. In all cases where live pupae were found, they were situated in the burrow slightly below this exit hole, with a plug of waste material beneath. (See fig. 3). Specimens submitted to Mr. H. G. Crawford, of the Dominion Entomological Branch, were identified as the common burdock borer *Papaipema nitela* Gn.

The injury caused by this insect consisted of a general stunting and lack of vigour in infested plants. The leaves did not fill properly after topping. Often the leaves on one side of the stalk would remain small and undeveloped, while those on the opposite side grew more rapidly. In some cases infested plants had broken off at the base during windstorms, due apparently to a weakening of the base of the stalk at the point of insect entry.

Blasting Injury

During the spring of 1925, a number of stumps and stones were removed by blasting from the fields comprising the recent addition to the Dominion Experimental Station at Harrow, Ontario. The material used was "Borrowite", a low grade dynamite. Some of these fields were later planted to tobacco.

Late in the growing season, as the tobacco crop was practically mature, Mr. D.D. Digges, Farm Superintendent, called to the writer's attention a peculiar condition of the leaves of those tobacco plants situated where a stump or stone had been removed. This condition was present to a greater extent on the upper leaves of the plants, and consisted at this time of a more or less complete absence of leaf web, so that badly affected leaves exhibited merely a skeleton framework consisting of the leaf midribs and veins. No lesions could be seen on any part of these plants at the time examined.

It seems probable that some constituent of the blasting powder used was instrumental in causing the leaf malformation noted. It will be of interest to observe if this condition recurs in 1926.

A Fusarium Leaf and Stem Diseas of Tobacco

Since the summer of 1918 a distinc type of leaf spot has been occasionally s on the leaves of tobacco plants, both in seed bed and in the field. It has been served in Kentucky, Wisconsin, Connecti and Massachusetts. Laboratory and gre house experiments have been conducted pi cipally at the Wisconsin Agricultural Exp ment Station, and at the Connecticut Toba Station. While no detailed study has be made of this disease, it is felt that suffici has been done to prove that it is undoubte of parasitic origin.

The leaf spots may occur at all stages plant growth from the small seedlings in t seed bed or greenhouse flat, to the large m

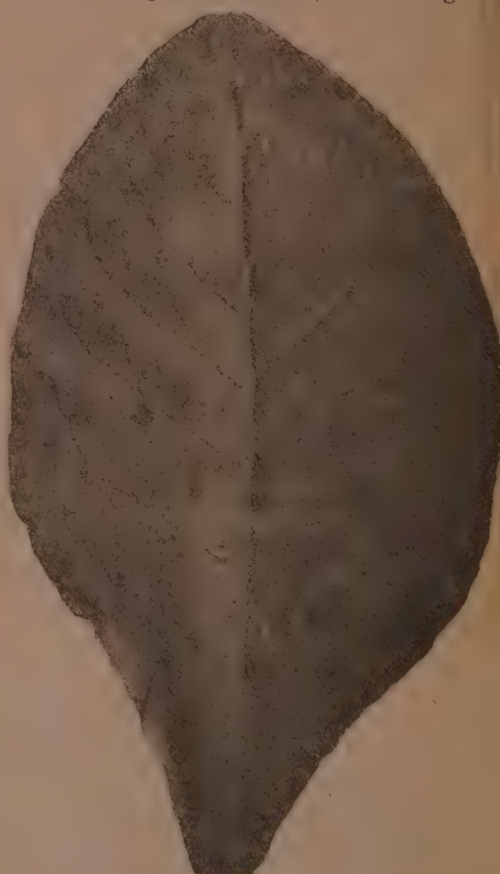

FIGURE 4.
Spotting of mature tobacco leaf believed du to a fungus closely resembling *F. affine* Faut. an Lamb. Specimen collected at Windsor, Connecticut August 1922.

ure plants in the field. When seen on large plants in the field they were always confined to leaves near the ground on the lower half of the stalk. The spots as seen on plants in the field are scattered irregularly over the leaf surface, are roughly circular in shape, light brown in colour, and usually much more prominent on the upper surface of the leaf. Fig. 4 shows typical leaf infection on a large field plant.

In addition to the leaf spotting mentioned, plants attacked in the seedling stage exhibited a variety of symptoms ranging from a type of "damping off", in very humid air, to a slight browning or girdling of the stem, in less humid air. In such cases the infection seemed to work back from the leaves toward the plant stem. The seedlings showing the stem girdling injury were always more or less stunted in appearance, and rarely reached transplantable size. (See Fig. 5).

Microscopic examinations of affected tissues showed the presence of fungus mycelium, and usually an abundance of conidia. Isolations made from leaf and stem lesions, and from single conidia, yielded a fungus closely resembling *Fusarium affine* Faut. and Lamb. (Fautrey, F., and Lambotte, E.,—Rev. Myc. Fr. *18*:68. 1896). Inoculations with this organism upon tobacco seedlings in the greenhouses at Madison, Wisconsin, reproduced the field symptoms on leaves and stems. Reisolation and reinoculations with single spore strains of this fungus produced a distinct spotting and disintegration of leaf tissues under moist conditions. The details of an inoculation experiment are given below.

May 14th. 1920, five potted White Burley tobacco plants four inches in height, and one flat of White Burley tobacco seedlings two inches in height, were inoculated with a spore suspension of culture 169 (closely resembling *F. affine*). One

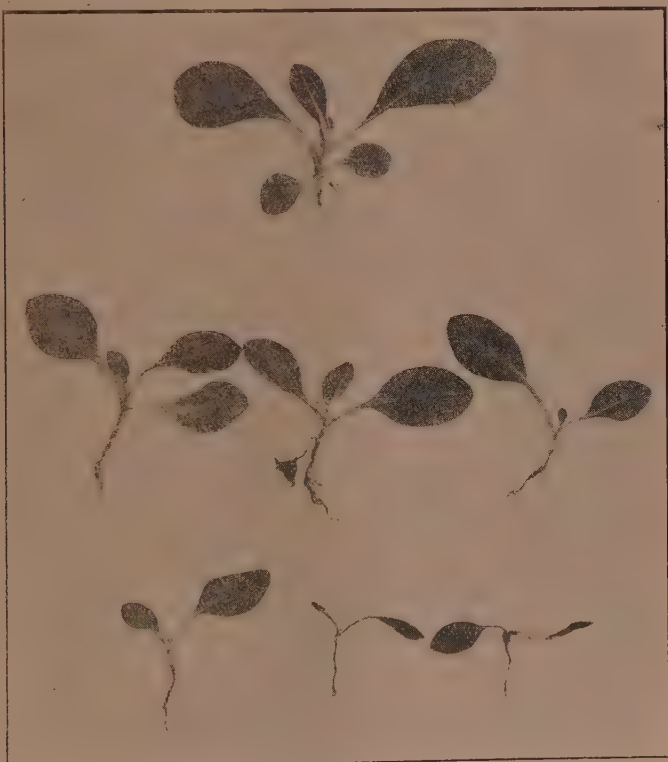

FIGURE 5.

Seedlings collected from a naturally infected greenhouse plot at Madison, Wisconsin, in March, 1922.
Upper Specimen—A normal, healthy seedling.
Central row—Three moderately infected seedlings.
Lower row—Three badly infected seedlings.

of the potted White Burley plants was inoculated by placing droplets of the spore suspension upon the surface of the leaves at a uniform distance from the leaf edge. A second plant was inoculated similarly except that a specially made dropping needle was used which punctured the leaf surface as the droplet was applied. Three more potted plants, and one flat of seedlings, were inoculated by atomizing the spore suspension upon the leaf surfaces. One potted plant, and one flat of seedlings, were atomized with sterile water as checks. All plants were placed in the same damp chamber at 24-25°C. May 19th.—All inoculated plants showed definite changes. Watersoaked, decaying spots surrounded the needle punctures on the wounded plant. Less distinct spots showed on the leaves inoculated with droplets without wounding. Many watersoaked spots were present on the leaves of the seedlings in the inoculated flat. The three large plants atomized with the spore suspension now showed leaves beginning to be discoloured, mottled, with darker green watersoaked areas distributed over the leaf surfaces. The check plants were unchanged. May 20th.—The check flat began to show signs of damping off, but the check plant remained healthy. The plants in the inoculated flat were almost entirely destroyed with damping off. The changes were much more marked on all the large inoculated plants. The lesions on the potted plants were much larger. The three plants inoculated by atomizing were going down very rapidly; the leaves drooped, the mottling was more distinct, the mottled spots tended to enlarge and coalesce, and the leaf tissues were rapidly disintegrating. The decaying leaf tissues were full of ramifying mycelium and conidia of a fungus similar to culture 169. All plants were removed from the damp chamber.

Inoculations using other organisms isolated from leaf spot and stem lesions on diseased plants gave entirely negative results. The spots produced by culture 169 under the conditions of the experiments were similar to those occurring naturally on seedlings but did not resemble those seen on field plants under natural conditions. The same fungus was, however, abundantly present in both cases.

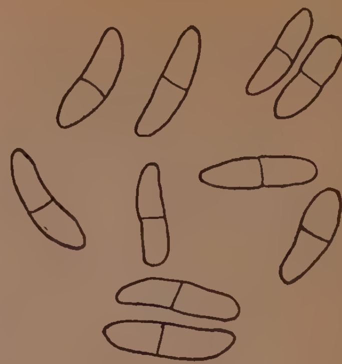

FIGURE 6.

Conidia of fungus resembling *Fusarium affine* Faut. and Lamb, collected from surface of infected tobacco seedling leaf; March, 1922. x 1000 drawn by aid of the camera lucida.

The fungus grows slowly in culture, producing very little aerial mycelium, but great numbers of white to salmon coloured conidia on potato dextrose agar. The entire growth on such agar slants assumes a salmon to buff colour. The conidia are hyaline, one-septate, straight or slightly curved, tapering slightly toward the apex. (See Fig. 6). Their size averages 3μ x 12μ. They are borne singly at the tips of digitoid conidiophores arising usually at right angles to the septate mycelium..

The Dry Rot Disease of Gladioli.

F. L. DRAYTON

Plant Pathologist, Central Experimental Farm, Ottawa.

The popularity of the gladiolus as a cut flower has increased greatly during the past five years, accompanied by a corresponding increase in its commercial culture. It is estimated that 300 acres were devoted to this purpose in Canada during 1925, and in Ontario the number of growers issuing catalogues and lists of varieties for sale, has increased from two or three in 1920 to 18 or 20 in 1925. It is thus becoming a horticultural crop of some importance commercially as well as to the amateur gardener.

On account of the increasing number of applications for information on diseases of gladioli, and the importance of having inspectors of plant and bulb importations familiar with the appearance of these diseases, it became necessary to devote some attention to the investigation of these troubles. While my attention has been directed on many occasions to a common and widespread as well as injurious disease, it was in the winter of 1923 that I made the first isolations from diseased material at my disposal. One fungus was obtained consistently from these isolations, and this has proved to be the one causing the so-called dry rot disease. After two seasons of field work, combined with as much laboratory work as time permitted, I am presenting a report, in order that our pathologists, growers, and inspectors can become conversant with the symptoms of this disease and certain control measures based on the results obtained from these field and laboratory studies.

Economic Importance of the Disease

It has not been possible yet to make a complete survey of the losses due to gladiolus diseases in Canada, but of this we can be certain, that the losses from corm rots, through the premature death of growing plants and the decay of corms in storage, are considerable every year and will increase as the industry becomes more commercialized.

Dr. L. M. Massey, in his bulletin on the hard rot disease, written in 1916, claims that the large proportion of loss in New York State was due to the hard rot, caused by *Septoria Gladioli* Pass. So far the only authentic specimen of this disease which I have seen is one which Dr. Massey kindly sent me last year; although it does occur in Canada, for Dr. Massey mentions having received some specimens of it from Mr. Groff of Simcoe, Ontario. From all accounts which have appeared in horticultural magazines, most prominent reference is made to hard rot, and dry rot is scarcely mentioned. I have no doubt that as far as Ontario is concerned most of the material referred to was really dry rot. The confusion of these diseases is quite excusable, for except in the early stages of infection on the corm, the two diseases can only be definitely distinguished by cultural means. It is a fact, however, that the disease is widespread, has been found in shipments from Holland, and is capable of causing severe losses.

In conversation with representatives of Dutch bulb firms visiting this country, I get the impression that while they have seen diseased material in Holland similar to that which I have shown them, they regard it as of little or no importance. This may be quite true under their conditions of soil and climate, but some idea of its potential importance here, can be inferred from the results obtained in field experiments. In the spring of 1924 cormels of ten varieties, artificially inoculated with material from pure cultures, were planted. On the average 30 per cent of the corms harvested; were diseased. In 1925 healthy planting stock was used in the same land and yielded a crop averaging 80 per cent, and in several varieties 100 per cent, diseased and worthless corms. Artificially inoculated sound planting stock the same year on clean land also produced a similar percentage of disease. This work was commenced in soil which has never grown glad-

ioli as long as the Central Experimental Farm has been in existence.

In consideration of the above facts, I believe that all growers will appreciate the importance of becoming familiar, as soon as possible, with the specific symptoms by which this disease may be recognized, and to be conversant with the suggestions I am able to make relative to prevention, based on my studies. In addition it is desirable to make the regulations governing foreign importations more stringent.

History and Literature

Dr. Massey in his bulletin, states that he had at his disposal an unpublished thesis by Mr. Errett Wallace, of Cornell University, written in 1909; also unpublished notes by Prof. F.C. Stewart of the New York (Geneva) Agricultural Experiment Station, as well as by Prof. H. M. Fitzpatrick of Cornell University. From these sources he gathered the following information:

1. Prior to 1909 Prof. Stewart mentioned distinctions between two types of rot.

2. From 1909 to 1912 Prof. Fitzpatrick and Mr. Wallace conducted some investigations on gladiolus rots which resulted in Mr. Wallace writing a thesis on Gladiolus Bulb Rots, and two articles in the magazines "Rural New Yorker" and "Gardening", in which he gives the names hard, dry and soft rots to three types of disease. Certain specific symptoms were described, but no mention was made of the causal organism.

Dr. Massey started his investigation of these diseases in 1912 and has continued with this work up to the present time. In 1916 he published his bulletin on the Hard Rot Disease, in which dry rot is occasionally mentioned in a comparative way. In the same year he wrote an article on Gladiolus Corm Diseases which was published in the "Modern Gladiolus Grower". In this dry rot is described briefly and the causal organism stated to be a fungus in which no spore stage had been observed. In 1917 Dr. Massey read a paper at the Pittsburg meeting of the American Phytopathological Society on the Dry Rot Disease.

In the United States Plant Disease Survey Report for 1922 the dry rot disease is mentioned as occurring in New York State.

Other diseases of the gladiolus have been described during the last few years. In 1921, Dr. Massey read a paper at the Toronto Meeting of the American Phytopathological Society on a Fusarium rot, and in 1924 Miss Lucia McCulloch described two bacterial diseases, *Bacterium gummisudans* and *Bacterium marginatum*.

Symptoms

On the Growing Plant:

No lesions are found on the leaves of diseased plants, nor can the fungus be induced to infect the leaves of young or old plants by the usual methods of inoculation. This constitutes one of the main differences between this disease and hard rot, in the leaf lesions of which the *Septoria* pycnidia are produced.

Plants which ultimately become diseased, grow without external symptoms for a period of six to eight weeks, then the leaves of the plant in groups in the rows turn yellow and later become brown and dry. (Figure 1.) At this stage the stem bends, decays at the surface of the soil and numerous small sclerotia are found at the base of the leaf sheath. (Figure 7C.) Saprophytic fungi are frequently found on the decaying stems and leaf sheaths below the ground level, and no doubt aid in the disintegration. Isolations of the causal fungus can however be obtained from the decayed tissues and from the sclerotia. In plants which become diseased late in the season, these symptoms do not progress beyond the yellowing of the leaves.

On removal of a diseased plant from the soil it is at once seen that the old corm is almost completely decayed and is invariably covered with saprophytic fungi, the new corm is small, its covering "scales" are dark in colour or spotted, (Figures 2 and 3) the roots are poorly developed and more or less decayed, cormel development is poor or absent, and in the case of a number of the *Primulinus* hybrids, which normally produce their cormels at the ends of prominent stolons, these stolons are dark in colour and decayed. The causal fungus is easily isolated from the corm, scales, roots and stolons of these diseased plants.

The premature death of the plant is no doubt due to the early decay of the parent corm and the progressive decay of the roots, but there is another factor of interest in this connection. A number of plants of which the gladiolus is one, produce normally contractile roots which are large and wrinkled on their surface. These function in three ways: (1) for the temporary storage of food material, (2) as a pulling organ to draw the

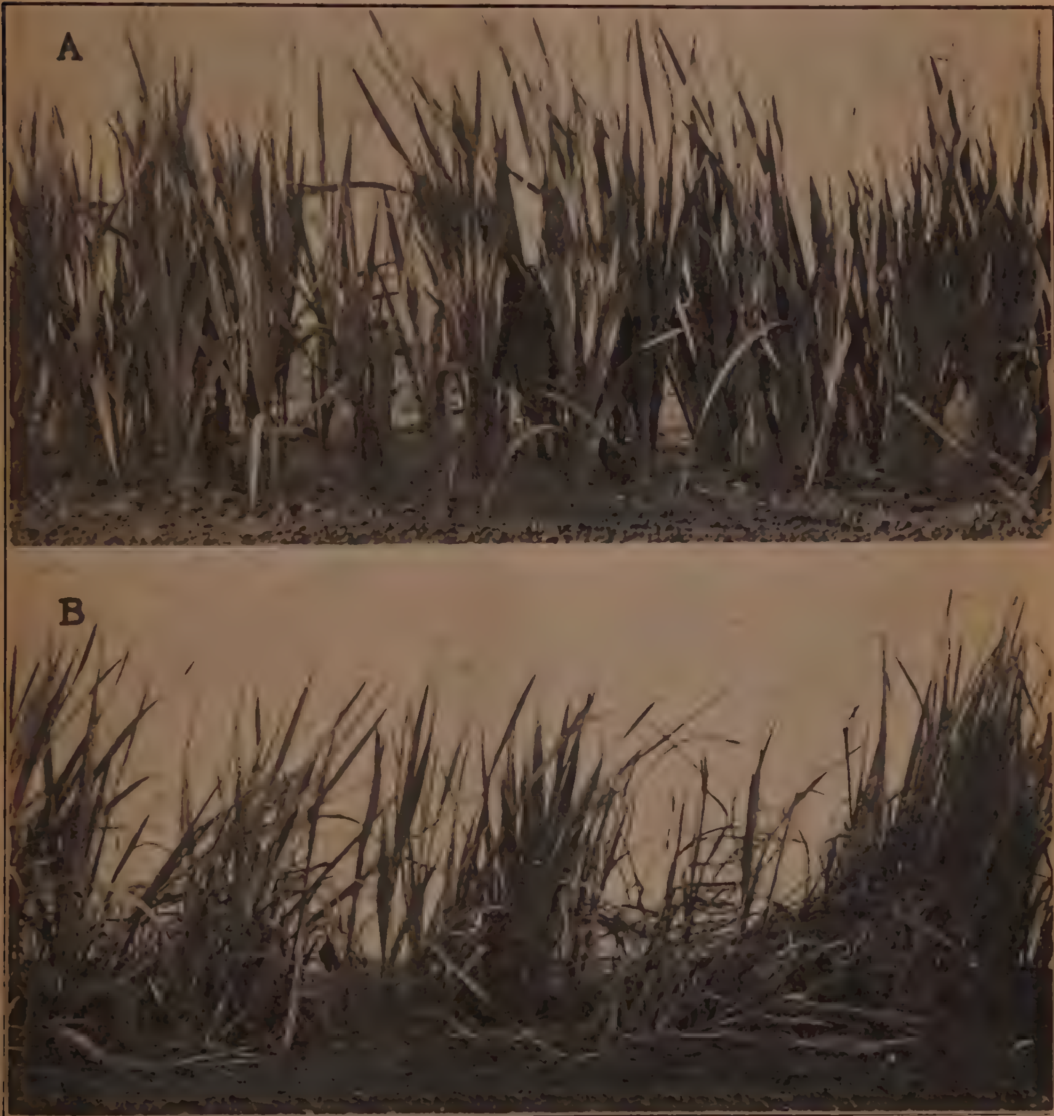

FIGURE 1.

A. Part of a check row of the variety Myra, photographed on October 9, 1925, after three light frosts. The plants are vigourous and the leaves green. The progeny of healthy corms planted on soil in which gladioli had never been grown.

B. Part of a row of the same variety, photographed on the same day and from the same distance. The majority of the plants are dead and the leaves and stems have fallen over and are brown. In most of the plants which are standing the leaves are yellow. The progeny of healthy corms planted in soil which had grown diseased plants the previous year. (Photos F. T. Shutt.)

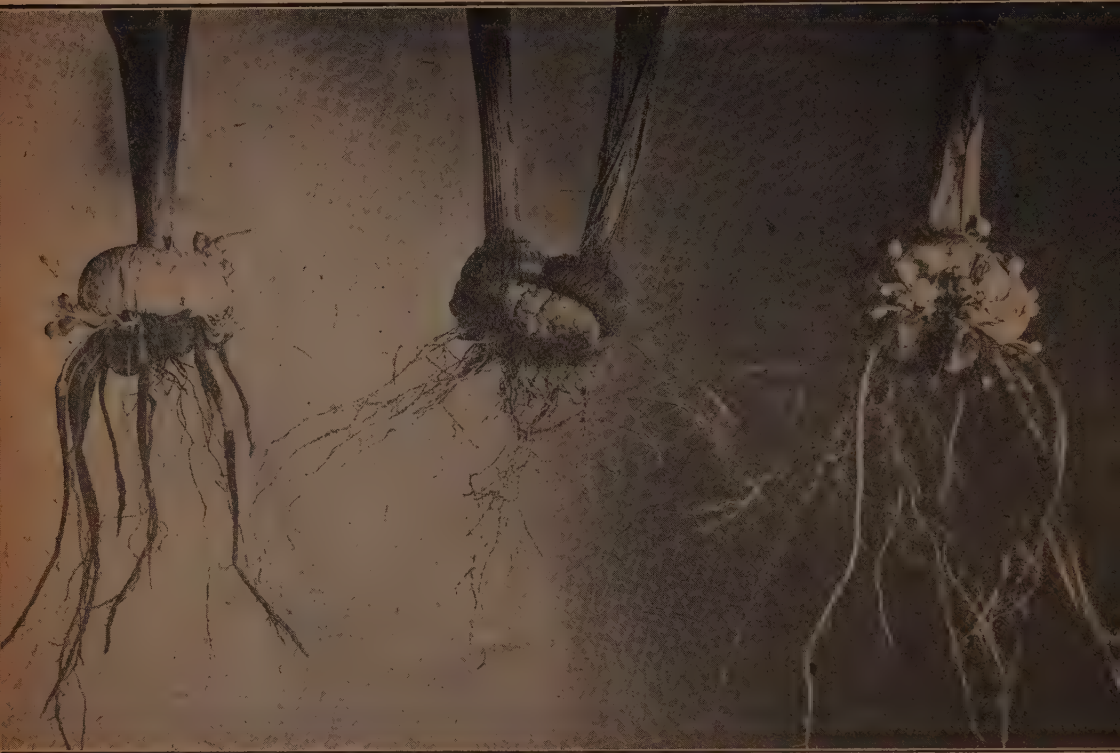

FIGURE 2.

Two healthy plants and one diseased, showing:

a. The difference in colour and size of the new corms.

b. Sound and decayed leaf sheath bases.

c. Good and bad cormel development.

d. The normal formation of contractile roots at the base of the new corms in the healthy plants and their absence in the diseased ones.

newly formed corm deeper into the soil, so that in their natural climatic conditions the new corms would not gradually move towards the surface, and (3) as an absorbing organ, for they produce root hairs on their branches and tips and aid in absorbing soil water after the original fibrous roots, produced at the base of the parent corm, become inadequate for the needs of the plant. These contractile roots are produced from underneath the newly forming corm (Figure 2), which originates at the base of the stem immediately above the parent corm. In the case of diseased plants the contractile roots are either not produced at all when infection takes place early; or in later infections are so small as to be incapable of sustaining plant growth. This absence or partial development only of these secondary roots is undoubtedly an important factor in the premature death of diseased plants.

On Harvested Corms and Cormels:

On careful examination of the corms when dug, the diseased ones show up more or less prominently because they are not only small and the corm scales dull brown or spotted (Figure 3), as compared with the large bright clean corms from healthy plants, but in addition lumps of soil are frequently found, sticking to their surface, apparently held by the development of the fungus mycelium, and the corm scales are partially decayed so as to expose portions of the corm below.

On removing the scales from a diseased corm, the surface is seen to have more or less numerous lesions, depending upon the ex-

ent of the infection. These lesions are sunen, reddish brown to black, dry and punky, nore or less circular, with definite and slighty elevated margin around a well defined ore. They vary in size from that of a pin point to 5 or more millimetres in diameter, either single or confluent, and in mild infections are usually located in the lower half of the corm. Most of the lesions do not penetrate for more than one or two milli-

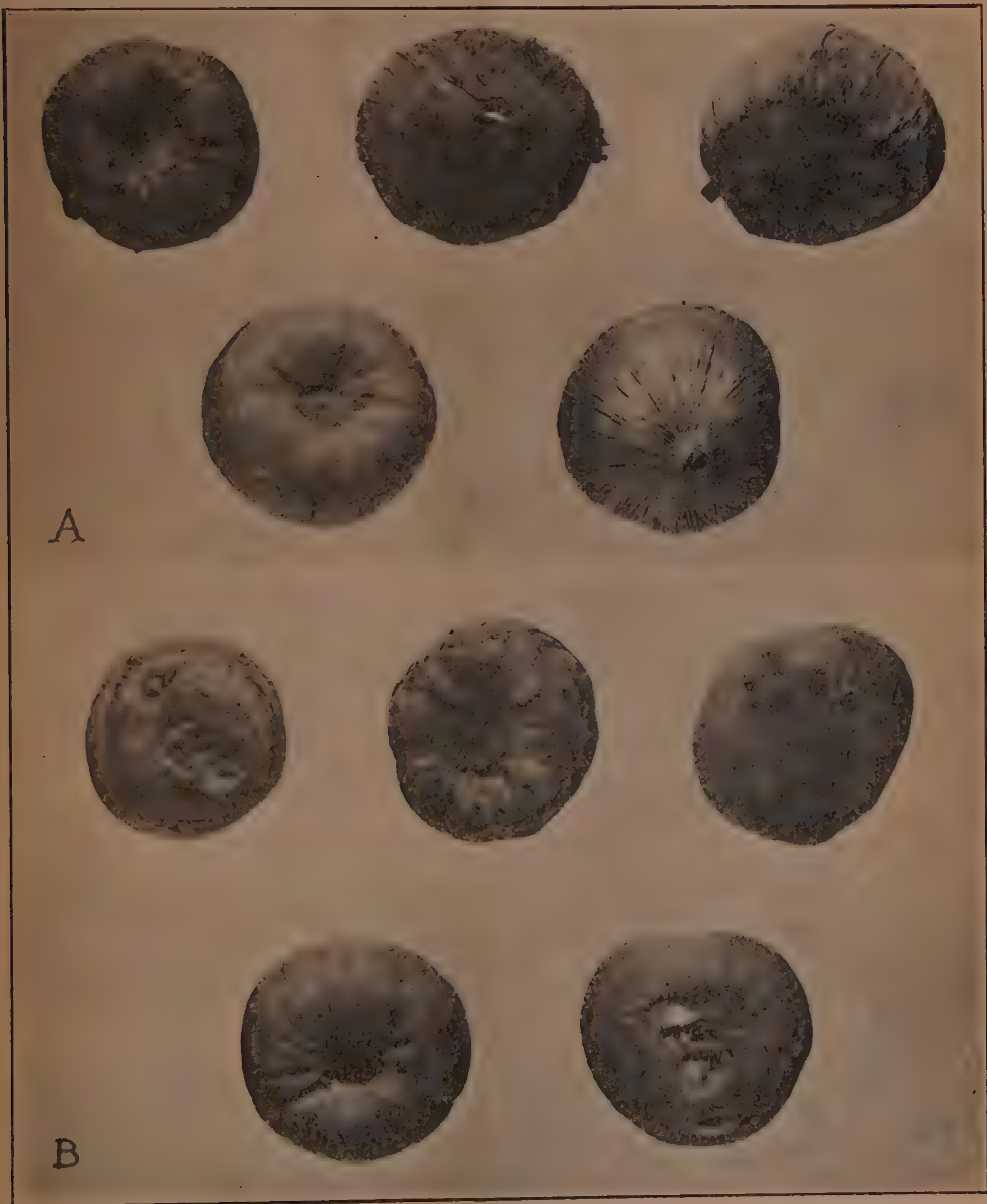

FIGURE 8.

Three diseased and two healthy corms, unskinned in A and skinned in B, showing the relationship between the corm scale discoloration or spotting, and the lesions on the corms beneath.

metres and are separated from the healthy tissues by a layer of cork cambium. The lesions can be lifted out with a needle leaving a saucer-shaped cavity lined with healthy tissue. In more sever infections, where the corms are nearly covered with lesions, or where the parent corm had completely decayed, the vascular bundles within the new corm become involved (Figure 4), and although it has not been determined where the fungus enters the vascular tissue, on cutting one of these corms vertically, dark brown lines, about one millimetre wide, can be traced following the vascular bundles. Isolations of this necrotic tissue yield pure cultures of the casual fungus. In this type of specimen, the buds at the top of the corm, with their special scaly covering, are blackened and dead, and it is an easy matter to isolate the causal fungus from this area also.

After the corms are cured, during the process of cleaning, in which the old corm and dried roots are removed from the base of the new corm, in the majority of diseased corms fragments of scales and roots are left in this

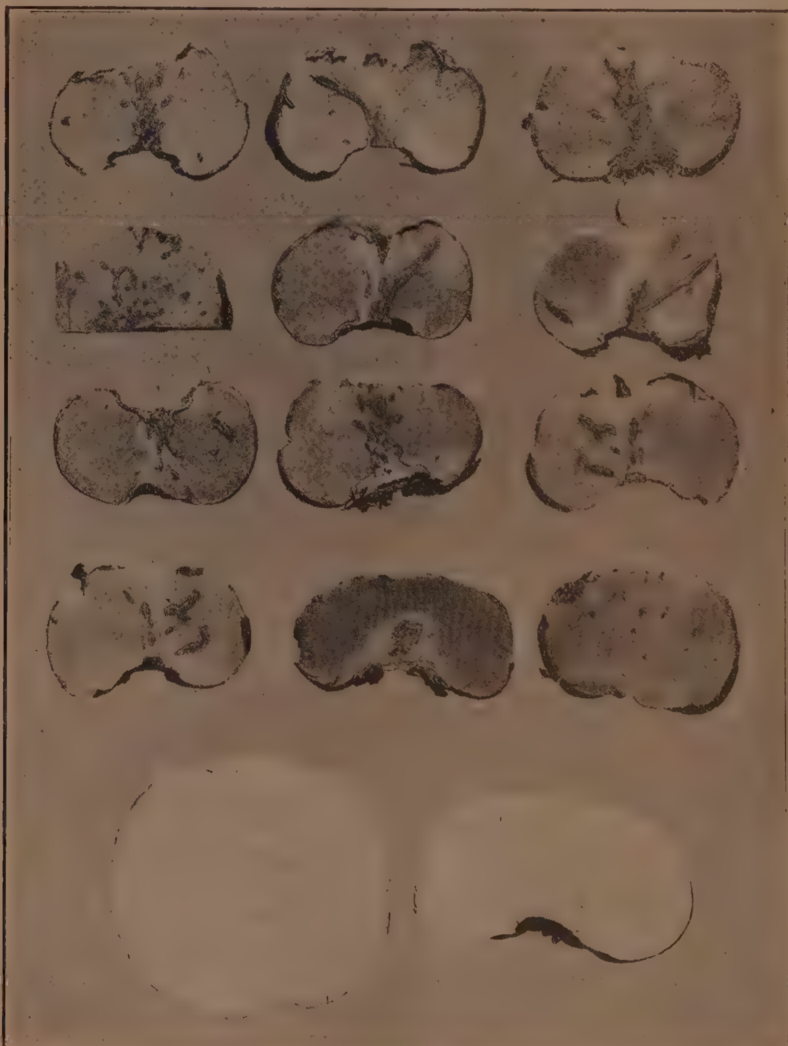

FIGURE 4.
Transverse and longitudinal sections of healthy and badly diseased corms, showing the vascular necrosis in the latter.

area, instead of the whole piece coming away and leaving a clean surface as in the case of healthy ones. At this time also specimens will be seen where the corm scales are discolored in patches. These indicate the presence of the fungus, as can be shown by culturing, and in almost every case there will be a corresponding lesion on the corm below. (Figure 3).

In storage the disease is progressive, by the further development of lesions, or by the spread of the fungus through adhering particles of soil, in moist and warm conditions. Badly diseased corms become completely mummied by spring. (Figure 5). In the storage of diseased material dug in the fall of 1924, 67% of them showed no sign of living tissue in the spring of 1925; conditions of storage were, however, rather too warm, and this percentage would not have been so high if the optimum temperature of storage, 40° to 45°F., had been maintained.

Cormels are occasionally found on diseased plants. When first dug these are smaller and often darker than those from healthy plants

FIGURE 5.
The disease is progressive in storage. Badly diseased corms become completely mummied by spring.

of the same variety. On removing the shells from cormels borne on diseased plants, about 50% of them will have lesions on the tissue below. (Figure 6). These lesions are similar to those found on the corms, and when a number of these are present the cormels also become mummied during storage.

In a mixed lot of cormels from diseased and healthy plants of the same variety it is practically impossible to distinguish them, for while the diseased ones have somewhat darker husks when first dug, after being cured the difference in colour is not sufficiently marked to permit of a separation by hand picking. This is a point of great importance, for these diseased cormels when planted become a source of infection of the soil and surrounding plants, by the fungus growing out from the lesions and husks, living mycelium having been found in both these tissues. This point is further discussed under the control measures recommended.

The Pathogen

The fungus originally and consistently found in many hundreds of isolations of diseased tissues has proved without doubt to be the cause of this disease, and was subsequently found to be identical with the fungus isolated by Dr. Massey as the cause of the disease originally named dry rot by Mr. Wallace. This was verified by an exchange of cultures between Dr. Massey and myself. Its pathogenicity has been proved by the experiments mentioned earlier in this paper in which 30 to 100 per cent infections have been obtained by the artificial inoculation of cormels and planting stock planted in soil which had never grown gladioli, the check plots always remaining healthy. Numerous re-isolations, from various parts of diseased plants, have always yielded the same fungus.

On all the types of media used for the culture of this fungus, the character of the growth is practically the same. When a piece of diseased tissue is placed on a potato dextrose or oatmeal agar slope, the mycelium grows out in 2 to 3 days at room temperature, in seven days the surface of the slope is covered, and in 10 to 14 days numerous sclerotia appear on the upper portion and sides of the slope and on the sides of the tube. The mycelium is white at first and later buff col-

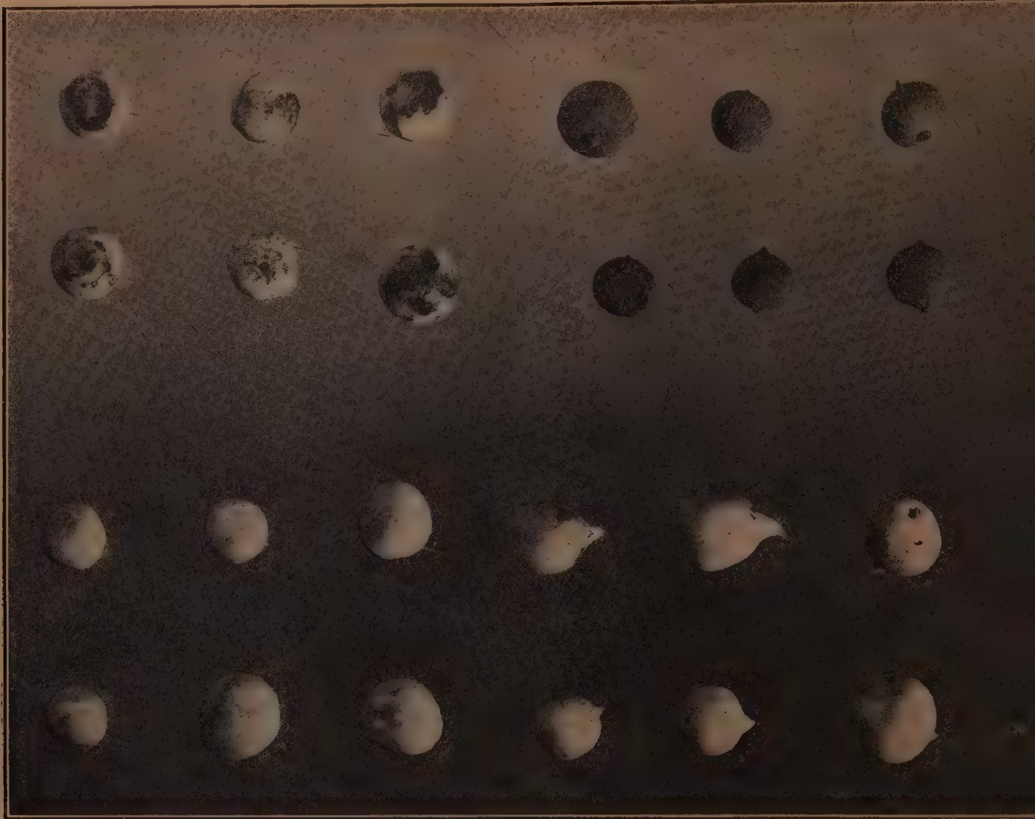

FIGURE 6.

Above, cormels from diseased plants; below, from healthy plants; photographed immediately after being dug. In the left half the cormel husks have been removed. This shows the smaller size, darker colour, and the lesions on those from diseased plants.

oured in the plug of aerial hyphae which appears at the top of the slope and completely fills the tube; over the thick portion of the slope a black sclerotial sheath develops. (Figure 7A and B.) The rapidity of the growth on culture of this fungus is in striking contrast with that of *Septoria Gladioli*, the cause of hard rot, which according to Dr. Massey, does not commence growth from a piece of diseased tissue until after 7 to 14 days; the appearance of the growth, also is quite different.

The sclerotia vary in size from 187 x 156 μ to 93 x 93μ with an average of 158 x 118μ. They are black and on being crushed on a slide exude an oily substance composed of small globules which stain black with osmic acid. They are identical with the sclerotia mentioned previously as being found on the decayed leaf sheaths of diseased plants. (Fi ure 7C.)

The hyphae are septate and vary from to 6.5μ in width. Their growth was descri ed as intracellular as opposed to the interce lular development of the hard rot by Wa lace and this my observations confirme The development of the mycelium in the cel is accompanied by a disappearance of t starch. In addition a cork cambium lay referred to previously, is developed by t corms in an effort to isolate the diseased t sue.

In comparing the life histories of the fun causing dry and hard rots, they are simil in that they both live in the soil for at lea four years even without the intervening plan ing of gladioli, as reported by Dr. Masse and they both produce corm lesions in whi

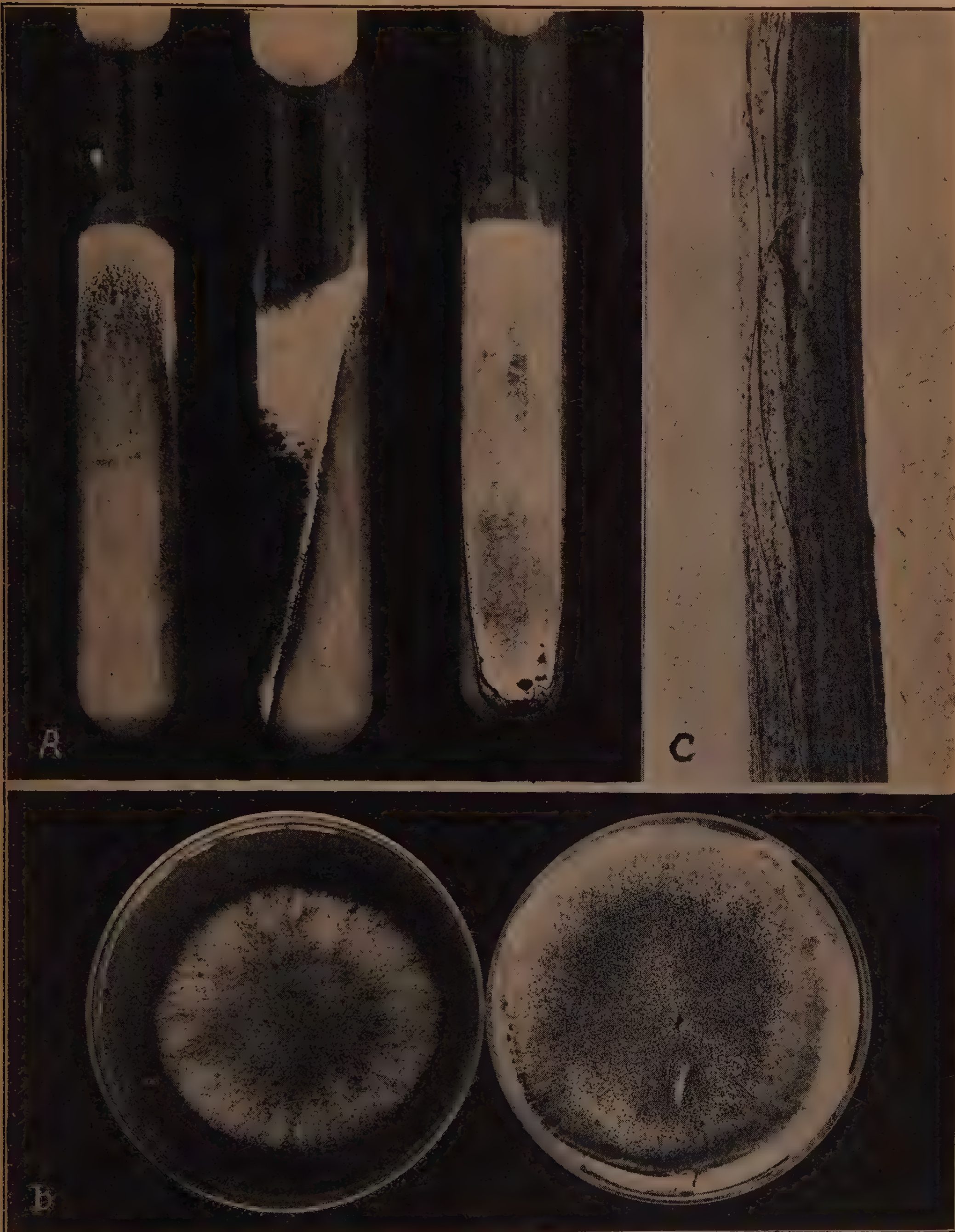

FIGURE 7.

A. Potato dextrose agar tube cultures of the causal fungus and B, petrie dish cultures; both showing the copious production of microsclerotia.

C. Basal leaf sheath of a diseased plant showing microsclerotia similar to those obtained in pure cultures.

the fungus lives over from one season to another, but the great difference lies in the fact that the hard rot fungus produces Septoria spores in leaf lesions and in culture, while as yet no spore stage has been found in the dry rot fungus although numerous attempts have been made to induce spore formation.

In Dr. Massey's paper on the dry rot read at Pittsburg in 1917, he suggests that the fungus causing dry rot be temporarily placed in the genus *Sclerotium.* The writer is trying various methods for finding or inducing a spore stage which might lead to a more satisfactory classification of this fungus.

As to the method of infection, the fungus apparently does not grow from a diseased parent corm directly into the new corm for diseased corms when planted have only given an average of 30% disease in the progeny. It seems more likely that the fungus either works along the leaf sheaths or grows out into the soil and so to the new corm. The presence of diseased areas on the corm scales corresponding with the lesions below would lead one to suspect that the fungus entered the corm through the sheath. These are points, however, on which further study is contemplated.

Control

Formalin, mercuric chloride, Uspulun, and Bayer Compound were used in field experiments for the treatment of diseased corms and as a drench for soil in which diseased plants had grown, also for soil in which artificially inoculated planting stock had been planted. The results showed that the treated plots varied little, if any, in the percentage of diseased progeny from the check plots, in the same variety. These results agree with those obtained by Dr. Massey for hard rot and dry rot.

In outlining the following recommendations, I have tried to introduce as little additional work as possible into the regular routine of gladiolus culture. They are based on practical experience as a grower as well as a plant pathologist.

1. The fungus causing this disease not only lives over in soil which has borne a diseased crop, but will continue to live there for a number of years. It is obvious then that these areas must not only be avoided for future planting of gladioli, but every precau tion must be taken to prevent the transfer ence of this soil to clean areas, either by cul tivating tools, ploughing machinery, by th feet of men and animals, or by wind in th case of a soil that is liable to drift.

2. Corms having lesions should under n circumstances be planted, because this con stitutes the most prominent means of intro ducing the fungus into a soil which may b free from it. In order to make sure that th corms are free from lesions it is necessar to remove the corm scales completely. Thi should be done just before planting, fo when done sooner, the corms become dry an sometimes valueless.

This recommendation is open to criticism It would entail a great deal of work in th case of a large grower, but I most strongl recommend this tedious procedure, especial ly in the case of newly purchased or valuabl varieties. Where gladiolus culture is carrie on extensively, the work of peeling all corm would render it almost prohibitive. Fiel experience, however, enables me to make fur ther suggestions that might assist where scal ing is not practicable.

3. Durng the growing season, when cul tivation or flower cutting is being done, sharp look-out should be kept for all plant showing the first symptoms of the trouble i.e.: a leaf yellowing. When such a plan or group of plants is found, they and th surrounding soil should be immediately re moved with a spade, placed in a box o wheelbarrow kept at the end of the rows, an disposed of in such a way as to preclude al possibility of contaminating clean soil. Wit the exception of an occasional drying of th leaf tips in hot weather, any deviation fro the normal green colour of the leaves, in climate similar to that of Ottawa, at any rate should be regarded as an indication of th presence of disease and dealt with according ly. Even the first two or three frosts in th fall have no appreciable effect on the leaves

4. At digging time a further opportunit is offered to get rid of diseased plants an their cormels. Any plants on being du which show any signs of decay on the stem or discoloration of the corm scales, shoul be placed in a separate container and suit

ably disposed of. While diseased corms may later be distinguished, it is impossible, as I have indicated previously, to separate the respective cormels of healthy and diseased plants, although the latter are capable of carrying the fungus and infecting soil when planted. The two recommendations last given offer an easy way of avoiding this source of contamination, which is one of great importance, and one which if overlooked will result in a spread of the disease, however careful the inspection of corms and quarantine of diseased soil may be.

5. When cleaning the corms in the winter another opportunity is afforded to eliminate diseased specimens. The lesions are usually seen in the lower half of the corm, and if not, discolorations of the corm scales with corresponding lesions below will be seen. The corm so effected should be discarded.

6. A further precautionary measure, which will well repay the trouble involved, is in the soaking of healthy corms selected from a mixture of healthy and diseased stock, in a five per cent. solution of formalin for thirty minutes. This will eliminate the possibility of infection from adhering soil and bits of corm scales from the diseased plants.

7. The inspectors at the ports of entry are now familiar with this disease, and a more careful search will be carried out in imported gladiolus stock. A percentage of disease will be set, above which the shipment will be condemned, and if any disease is found in a shipment permitted entry, the grower will be notified of its presence and the necessary precautions to adopt.

8. When the gladiolus industry has grown to a stage where inspection and certification is warranted ,these will further help to keep this disease in check.

As to differences in varietal susceptibility, field experiments showed that the Primulinus hybrids, Myra, Alice Tiplady, Salmon Beauty, and Maiden's Blush, were more susceptible than the Gandavensis types, Evelyn Kirtland, Le Marechal Foch, Mrs. Frank Pendleton, Crimson Glow, Mary Pickford, and Goliath. This may be accounted for by the fact that the latter types have somewhat thicker corm scales. Further studies, however, will be made on this point.

In conclusion, I desire to state that were it not for the fact that practical experience has revealed satisfactory means for keeping gladioli free from this disease, I would not have directed the attention of growers and plant pathologists to this investigation, which, as I have intimated, is not by any means concluded.

ACKNOWLEDGEMENTS

The kindly criticism and willing help given to the author by the Dominion Botanist, Mr. H. T. Güssow, has been of great assistance in the pursuance of this work.

I am also indebted to Dr. L. M. Massey of Cornell University for his kindly assistance in the exchange of cultures and diseased material.

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Experiments with "Soilgro"

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Introduction

In the spring of 1925, a vigorous campaign was inaugurated on the part of the manufacturers of a preparation called "Soilgro" which is claimed to be, in the words of the label: "A scientific bacteria culture for all forms of plant life. Increases size, quantity and quality of products, expedites maturity of growth. Especially fine for lawns, flowers, vegetables, grains, fruits, etc."

The preparation comes in two packages. One, "Soilgro" proper, is a liquid supposed to contain the beneficial bacteria. The other package contains what is called "Bacteria Food," substances on which the bacteria of the first package are able to thrive and multiply, the contents having the appearance of a mixture of sandy soil and manure. Each tin contains approximately 2½ imperial quarts. The two tins are sold together and retail for $6.00.

The culture is stated to contain "Different groups of nitrogen-fixing, ammonifying, nitrifying and decomposition bacteria" and is stated to be adaptable to all types of crops. In view of the fact that up to the present time the use of bacterial cultures had been shown to be of practical benefit only in the case of leguminous crops, the claim advanced on behalf of this culture appeared to be rather sweeping. For this reason, it was thought advisable to conduct tests on this product in order to obtain some idea of the nature of the substance, the types of bacteria contained and the effect on crops treated with the culture. For the purpose of experimentation as described below several packages of "Soilgro" were purchased in the usual way from dealers.

Chemical Analysis, Etc.

The "Soilgro" (liquid) tin contained a brownish turbid liquid, smelling like dilute sewage. When first opened, a very strong odor of hydrogen sulphide was apparent. The liquid was slightly alkaline (pH=7.6), contained ammonia, gave positive tests for chlorides and lime, negative tests for nitrites and nitrates.

The "Bacteria Food" had the appearance of sandy soil mixed with horse manure, was somewhat moist and practically odourless.

The chemical analysis of the contents of the two tins, for which we are indebted to the Dominion Chemist, is given in Table 1.

Table 1.

Chemical analysis of "Soilgro" and "Bacteria Food".

	Soilgro	Bacteria Food
Water	99.84%	20.40%
Organic matter	.06	7.89
Ash	.10	71.71
Nitrogen	.006	.28
Phosphoric acid (P_2O_5)	.003	.248
Potash (K_2O)	.015	.406

The total plant food value of the contents of the two packages was also estimated, it being assumed that the various food ingredients were 100 per cent available.

Plant food value of contents of "Soilgro" package .... 0.014 cents
Plant food value of contents of "Bacteria Food" .... 0.658 "

Total plant food value of contents 0.672 "

Bacteriological Analysis

For most of the bacteriological determinations and for all crop experiments, "Soilgro" as prepared for use was employed, following the directions given.

To prepare "Soilgro" for use, the contents of both tins were mixed in an 8-gallon can and water added (5 times the amount of the Soilgro tin). The whole was well stirred and left to stand for 5 days, according to directions, after which time it was ready for use.

Received for publication, December 19, 1925.

TABLE 2.

Numbers of bacteria developing on various media from Soilgro, manure-soil decoction and garden soil.

	Soilgro (prepared) per cc.	Manure-soil decoction per cc.	Garden-soil per gram.
Beef peptone agar—			
Total bacteria	2,950,000	43,300,000	28,800,000
actinomycetes	130,000	70,000	1,800,000
Soil-extract agar—			
Total bacteria	700,000	24,000,000	38,500,000
actinomycetes	110,000	130,000	5,000,000
Beef-peptone gelatine—			
Total bacteria	450,000	26,300,000	27,600,000
rapid liquefiers	17,000	9,000,000	1,800,000

TABLE 3.

Numbers of bacteria in Soilgro liquid and Bacteria Food.

	Soilgro liquid per cc.	Bacteria Food per gram.
Beef-peptone agar, total count	320,000	20,000,000
Beef-peptone gelatine, total count	28,000	7,800,000
Beef-peptone gelatine, rapid liquefiers	2,500	600,000

Along with the tests on Soilgro were conducted parallel tests with an ordinary garden soil and also with a manure and soil decoction prepared in the laboratory to approximate the general appearance of Soilgro. This was prepared by making our infusion of hog-manure, clover-hay and soil in water. The liquid was decanted off and diluted with water to the proper colour. A mixture of soil and horse-manure was used to approximate the "Bacteria Food". The finished preparation had much the same appearance as Soilgro.

In Table 2 are given the results of counts of the number of bacteria by the plate method.

In order to obtain some idea of the relative numbers of bacteria contained in the two packages, counts were also made with freshly opened tins, shown in Table 3.

From Table 3 it is noted that the numbers of bacteria found in the "Bacteria Food" are much in excess of those found in the "culture" itself. It is further seen from Table 2 that ordinary garden soil and a very dilute manure-soil decoction contained more organisms in the media employed than Soilgro as prepared for use.

On the types of Bacteria Found

Special tests were conducted to note the presence of the different groups of bacteria concerned with the nitrogen transformations namely, ammonifiers, nitrifiers and nitrogen fixing bacteria. While these three groups were all found to be present in the "Bacteria Food" yet in Soilgro liquid, which represents the culture proper, ammonifying bacteria only could be detected in appreciable amount. A trace of the nitrifying bacteria was found, though *Azotobacter* could not be discovered.

Quantitative estimations by the dilution method were conducted to note the approximate numbers of these groups in Soilgro (pre-

TABLE 4.

Approximate numbers of ammonifiers, nitrifiers and Azotobacter by the dilution method.

	Soilgro (prepared)	Manure-soil decoction	Garden-soil
	per cc.	per cc.	per gram
Ammonifiers (in 0.5 per cent gelatine)	300,000	5,000,000	10,000,000
Nitrifying bacteria	1,000	100	50,000
Azotobacter	less than 10	less than 10	25,000

TABLE 5.

Nitrogen assimilation by Soilgro, *manure-soil decoction and garden-soil.*

Inoculum	Milligrams nitrogen at start	after 28 days	Gain in nitrogen milligrams	
Soilgro 1	2.0	8.0	6.0	6.2
" 2	2.0	8.4	6.4	
Manure-soil decoction 1	0.8	4.8	4.0	4.1
" " " 2	0.8	5.0	4.2	
Garden Soil 1	7.3	24.8	17.5	16.3
" " 2	7.5	22.7	15.2	

TABLE 6.

Pot tests on Huron Wheat.

Treatment	Average Height in Inches 2 weeks	4 weeks	8 weeks	12½ weeks	Average Weight grams
Soilgro	6.0	13.5	26.4	27.3	3.72
Soilgro sterilized	5.7	12.6	25.5	26.0	3.60
Manure-soil decoction	5.9	12.6	25.3	26.7	4.06
Check—no treatment	5.8	14.2	27.6	28.9	3.68

pared), in manure-soil decoction and in garden-soil, with the results as given in Table 4.

Garden soil appears to contain not only more ammonifying and nitrifying bacteria, but also considerably more *Azotobacter* organisms, which are the most important free-living group of bacteria capable of fixing atmospheric nitrogen.

In connection with the question of nitrogen fixation some quantitative tests were conducted to note the amount of nitrogen assimilation in a solution to which was added Soilgro, manure-soil decoction and garden soil in equal amount. To 100 cc. of Ashby's solution 5 cc. or 5 gram of the substance to be tested was added. The cultures were incubated at room temperature for 28 days and total nitrogen determined. The amount of nitrogen was also determined in check samples containing the solution and the inoculum without incubating. (Table 5).

Nitrogen assimilation in solution by garden soil was considerably in excess of that effected by Soilgro.

Pot Experiments (Greenhouse)

(a) WHEAT.

On May 14, 1925, pots of ordinary field soil were planted with 6 seeds each of Huron wheat, duplicate pots being used for the various treatments. In one set the seeds were soaked for 4 hours in Soilgro before planting while applications of Soilgro were made on May 26, June 5, and June 11. Another set received the identical treatment only the Soilgro was sterilized before using. A third set received similar treatment using a dilute manure-soil decoction, while for a fourth set the seeds received no treatment. At regular intervals the height of the plants was recorded until finally on Aug. 11th, the plants were cut close to the soil and weighed. Results are shown in Table 6.

The results in Table 6 do not reveal differences in growth which indicate any beneficial effect of Soilgro. As it happened, the untreated plants were slightly higher than those treated with Soilgro, and a fraction of a gram lighter (see Fig. 1). Those treated with the home-made "culture", which represented a very dilute manure solution, were slightly heavier than those to which Soilgro was applied.

(b) Legumes in Sterile Sand.

This test was conducted to note whether Soilgro was capable of inducing nodule formation due to the action of *B. radicicola*, the organism associated with legumes which permits of utilization of atmospheric nitrogen by the growing plant. The seeds used were first disinfected to remove any nodule bacteria present, and one lot was then treated with Soilgro while for comparison another lot was treated with nitro-culture. A third lot remained untreated. Seeds were then planted in small pots of sterilized sand to which was added from time to time a sterile solution containing plant nutrients with the exception of the element nitrogen. Sterile water was used in watering while care was taken to protect the plants from accidental contamination.

FIGURE 1

Pot tests with wheat: left, Soilgro treatment; right, untreated.

(Photo by H. R. Murray)

It was found that whereas the plants which had received the nitro-culture (containing *B. radicicola*) developed normally, both the untreated lots and those treated with Soilgro grew poorly, and with the utilization of the reserve nitrogen in the seed finally failed on account of nitrogen starvation (see Fig. 2). On examination of the roots it was found that those from plants treated with nitro-culture showed the presence of nodules while those from the other lots failed to show any trace of legume bacteria.

Table 7.

Growth of peas in sterile sand without nitrogen. (see Fig. 2)

Treatment	Growth	Average No. of nodules (per plant)
Soilgro	poor	0
Check-no treatment	poor	0
Check-nitro-culture	good	46

Similar results were obtained with beans, the only other legume tested. It is evident that for certain legumes at least, Soilgro is unable to supply the proper strain of *B. radicicola* required for nodule development.

Field Experiments

In connection with the following tests with "Soilgro" under field conditions, we are indebted to the Dominion Field Husbandman, and to the Superintendents of the Experimental Stations at Fredericton and Charlottetown for their co-operation.

(a) Oats (Location—Ottawa)

Nine plots, each 1/20 acre in area on clay soil, were employed, three methods of treatment being replicated three times. With three plots no treatment was used, on three plots the oats were treated with Soilgro, while on three others a similar treatment was used with

TABLE 8.

Results of field tests with Banner Oats (Ottawa)

Plot No.	Treatment	Plot Yield Straw lbs.	Plot Yield Grain lbs.	Yield per Acre Straw tons	Yield per Acre Grain bus.
1-1	Check—No treatment	226	129	2.26	75.9
1-2	Soilgro	206	123	2.06	72.4
1-3	Sterilized Soilgro	203	131	2.03	77.1
1-4	Check—No treatment	187	126	1.87	74.1
1-5	Soilgro	181	104	1.81	61.2
1-6	Sterilized Soilgro	174	108	1.74	63.5
1-7	Check—No treatment	193	123	1.93	72.4
1-8	Soilgro	232	111	2.32	65.3
1-9	Sterilized Soilgro	201	113	2.01	66.5

The average yield for each series was as follows:

Soilgro ....2.06 tons straw, 66.3 bus. grain per acre.
Sterilized Soilgro ...1.93 " " 69.0 " " " "
No treatment ....2.02 " " 74.1 " " " "

Soilgro which had been sterilized, care being taken that all bacteria in the culture were killed. The results are shown in Table 8.

In this test the untreated plots gave a higher yield of grain than the plots where Soilgro was applied. Even when the culture was kill-by sterilization the yield of grain was slightly higher than with the culture.

(b) CORN (LOCATION—OTTAWA)

Eight plots, each 2/125 acre in size, of sandy loam soil were used, and corn was planted after treatment with Soilgro, with sterilized Soilgro and without treatment. Results are given in Table 9.

TABLE 9.

Results of field tests with Corn. (Ottawa)

Plot No.	Treatment	YIELD Plots (lbs.)	YIELD Tons per acre
1 B 1 a	Sterilized Soilgro	658	20.56
1 B 1 b	Check—No treatment	617	19.28
1 B 2 a	Soilgro	648	20.25
1 B 2 b	Check—No treatment	584	18.25
1 B 3 a	Sterilized Soilgro	687	21.47
1 B 3 b	Check—No treatment	568	17.75
1 B 4 a	Soilgro	622	19.44
1 B 4 b	Check—No treatment	590	18.44

The average yields were as follows:

Soilgro ....19.84 tons per acr
Sterilized Soilgro ......21.01 " " "
No treatment ....18.43 " " "

In this case the Soilgro treated gave a higl er figure than the untreated, but any clai that the bacterial culture is responsible fo this is offset by the fact that the seeds in mersed in the liquid in which all the bacteri had been killed gave higher results than wit the "culture."

(c) CORN (LOCATION—FREDERICTON)

Corn was planted in rows 450 ft.long, thre rows being treated with Soilgro and thre left untreated with results as follows:—

Corn—Soilgro Treatment...7.40 tons per ac
" No treatment ......8.76 " " "

In this test the reverse of the result of th Ottawa test was found, namely the untreate corn showed up better than that treated wi Soilgro.

(d) POTATOES (LOCATION—FREDERICTON)

This test was carried out in two adjace rows, 169 ft. long, the experiment not bein replicated. The results of the total yields we as follows:

Potatoes—Soilgro Treatment ......23649 lbs. merchantable ....1478 lbs. small
No treatment ....18954 lbs. merchantable, ...1304 lbs. small

In this case the treated crop showed a heavier yield than the untreated.

(e) CABBAGE (LOCATION—FREDERICTON)

The tests with a number of different varieties are summarized in Table 10.

TABLE 10.

Results of field tests with Cabbage (Fredericton)

Variety	Treatment	No. Head	Total weight lbs.	Aver. per head lbs.
Stone Head	Soilgro	10	50	5.0
"	No treatment	10	51	5.1
Danish Ball Head	Soilgro	10	84	8.4
" "	No treatment	30	221	7.4
Marblehead Mammoth	Soilgro	10	72	7.2
" "	No treatment	29	213	7.3
Savoy	Soilgro	10	55	5.5
"	No treatment	10	49	4.9
No. 2 Danish Ball Head	Soilgro	37	228	6.1
" " " "	No treatment	19	100	5.2
No. 41 Summer Ball Head	Soilgro	10	62	6.2
" " " "	No treatment	7	67	9.5
No. 46 Danish Ball Head	Soilgro	9	50	5.5
" " " "	No treatment	6	40	6.6
No. 49 Imp. Amager Curled Savoy	Soilgro	7	26	3.7
" " " " "	No treatment	7	37	5.3

The average figures for all varieties are as follows:

Cabbage—
Soilgro.....average wt. per head—5.95lb.
No treatment " " " " —6.41 "

FIGURE 2.
Test for presence of nodule bacteria (*B. radicicola*) Peas grown in sterile sand, plant nutrients being added with the exception of nitrogen.
(Photo by H. R. Murray)

(f) Carrots (Location—Fredericton)

Tests were conducted in 33 ft. rows with Chantenay carrots with results as follows:

Carrots—Soilgro ....yield—130 carrots, weight 39 lb.
" No treatment .... " —169 " " 56 "

Here there is an apparent advantage in not treating, though in the case of beets following, the reverse is the case.

(g) Beets (Location—Fredericton)

Detroit Dark Red Beets were grown in 34 ft. rows with the following results:
Beets—Soilgro ....yield—47 beets, weight 64 lb.
No treatment.................. " —45 " " 47 "

(h) Strawberries (Location—Fredericton)

This experiment was carried out on a strawberry block which was two years old, and had previously produced one crop of strawberries. Soilgro was applied as a spray. Th results are shown in Table 11.

Table 11.

Results of tests with Strawberries (Fredericton)

Variety	Length of row	Treatment	Total yield (quarts)
Americus	33 ft.	Soilgro	18.9
"	" "	No treatment	20.4
Parsons Beauty	33 ft.	Soilgro	27.3
" "	" "	No treatment	28.9
Portia	11½ "	Soilgro	14.9
"	" "	No treatment	15.9
Bianca	18 "	Soilgro	10.3
"	" "	No treatment	11.3
Total yield	....	Soilgro	71.4 quarts
" "	....	No treatment	76.5 "

In this case the total yield of the untreated plants was somewhat higher than that of plants which received treatment with Soilgro.

The various field crop tests are summariz in Table 12 with respect to the yields bein in favor of Soilgro or untreated crops.

Table 12.

Field Crop Summary

Crop	Location	Yield % in favor of Soilgro	Yield % in favo of untreated
Oats	Ottawa		11.3
Corn	"	7.6	
Corn	Fredericton		18.3
Potatoes	"	24.8	
Cabbage	"		7.7
Carrots	"		43.6
Beets	"	36.2	
Strawberries	"		7.1

In considering the various field crop tests, it is seen that in some cases the treated, but in an even greater number of cases the untreated crops gave a higher yield. With field experiments no two areas of the same crop, even under the same conditions of treatment and cultivation will produce identical crop yields. Local differences in soil and environment always lead towards a certain unavoidable variation tending to be greatest in those cases (e.g. potatoes, carrots, beets) where room for replication was not available. Consequently we do not infer that Soilgro is to be regarded as actually harmful in those cases where the crop yields were heavier without treatment, and in like manner we believe a similar judgment should be exercised in considering those cases where yields have apparently favoured the culture.

Taking the results of the field tests as a whole, we consider the culture to be valueless, which judgment bears out the results of the more accurately controllable greenhouse tests in pots, and the results of the bacteriological laboratory tests.

Note

Since the above data were accumulated, there has come to our notice the report of tests made with "Soilgro" by L. T. Leonard (1) of the Bureau of Plant Industry, United States Department of Agriculture. The results of these tests are entirely in agreement with our own, and indicate no practical benefit to be derived from the use of this culture. This is shown, not only by the bacteriological examination of the preparation, but also by tests made with the crops tried out, namely radishes, peas, and with lawns.

Total bacteria, ammonifying and cellulose decomposing organisms were found to be much fewer in number in "Soilgro" culture than in the so-called "Bacteria Food" and also in soil and manure samples tested for comparison. Furthermore, "Soilgro" was found to be inferior to potting soil, both as regards nitrogen-fixing power and ability to cause nitrification of ammonium salts.

Tests with radishes showed no superiority on the part of "Soilgro", either in the stimulation of germination, earliness of crop or weight of crop, while tests made with peas were likewise negative. The same negative results were found when "Soilgro" was applied to lawns.

Reference

(1) Lewis T. Leonard. Some Tests with Soilgro. Journal of the American Society of Agronomy. Vol. 17, p. 623. Oct. 1925.

CORRECTION

In the article "Some Statistical Observations on a Yield Test of Potato Varieties", Vol. 6, p. 92, 1925, the statement is made that the Deviation of the Mean method is briefly described in Haye's and Garber's "Breeding Crop Plants". The method referred to by Hayes and Garber was not the Deviation of the Mean method but only a modification of Wood and Stratton's pairing method. The Deviation of the Mean method was first briefly described by Hayes in an article entitled "Controlling Experimental Error in Nursery Trials," Journal America Society of Agronomy, 15, p. 188 and more fully outlined by the same author in Technical Bulletin 30 of the Minnesota Agr. Exp. Station, September, 1925.

In this article, also, the authors omitted to state that in calculating the correlation coefficients between the yields of plots different distances apart, the yields were first corrected for varietal differences. The method of correction was to divide the yield of each plot by the average yield for that variety and multiply by the average yield of all the plots in the field. This is comparable to putting the yields on a percentage basis and is necessary when the yields of different varieties are being correlated, in order to avoid spurious correlation.

L. E. Kirk and C. H. Goulden.

Nos Terres Manquent-elles de Soufre?

A LEDUC

Professeur à l'Institut Agricole d'Oka

Le soufre est l'un des dix éléments essentiels à la nutrition des plantes. Suivant Czapeck, ce fait ne serait connu que depuis 1882.

D'où vient le soufre des plantes resta pendant longtemps une question. Liebig fut le premier à reconnaître que c'est dans le sol que les plantes trouvent le soufre dont elles ont besoin et qu'elles absorbent par leurs racines. Mais la forme suivant laquelle le soufre est absorbé fut inconnue pendant un certain temps. Maintenant, on croît généralement que c'est sous forme de sulfates, ions SO_4, que le soufre est absorbé, une partie servant à la formation des matières protéiques, une partie à la formation d'huiles volatiles et une autre restant sous forme de sulfates.

On n'a pas encore déterminé pour aucun des éléments essentiels le besoin minimum nécessaire au développement maximum des plantes. Pouvons-nous croire que le sol manque de soufre dans certains cas?

Bogdanof, (I) le premier, peut-être, indiqua les relations qu'il y a entre la quantité de soufre enlevée au sol par les plantes et la quantité que l'on trouve dans le sol. Il émit la possibilité d'un épuisement du soufre dans les terres cultivées.

Les physiologistes et les chimistes agricoles s'occupèrent peu de la question du soufre avant et même après Bogdanof, à cause, en grande partie, du manque de moyens analytiques faciles pour en faire le détermination. Ils acceptèrent simplement le résultat des analyses des cendres par Wolff (2). Se basant sur la quantité de soufre fournie au sol par divers agents et la quantité enlevée par les récoltes et déterminée par incinération, ils conclurent que la balance du soufre dans le sol était bonne. Les analyses des cendres sont l'analyse du résidu provenant de l'incinération des plantes et il a été prouvé qu'au cours de l'incinération une grande partie du soufre se perd par volatilisation.

Hart et Peterson (3) se servirent de la méthode Osborne pour leurs déterminations du soufre; cette méthode consiste à fondre avec précaution de la substance végétale avec du peroxyde de sodium et présente l'avantage d'assurer l'oxydation du soufre présent dans les plantes sous forme de combinaisons organiques sans qu'il y ait perte par volatilisation. La table II, tirée des résultats obtenus par Hart et Peterson et compilée par Shedd, indique bien la différence entre les quantités de soufre trouvées dans quelques plantes par la méthode au peroxyde de sodium et celles trouvées par la vieille méthode par incinération. Cette table II nous fait voir des différences très grandes; jusqu'à quarante-deux fois plus de soufre fut constaté par la méthode au peroxyde.

Il ne semble donc pas impossible, en présence des nouvelles données, que certains sols puissent manquer de soufre. Etudions la question; cherchons ce que le sol contient de soufre, la quantité qui est fournie par diverses sources et la quantité enlevée par les récoltes et l'eau de drainage.

Le soufre du sol.

Les données sur les analyses du sol ne fournissent pas des informations précises ni complètes sur la quantité de soufre que contient le sol, mais néanmoins, elles indiquent que les terres contiennent généralement moins de soufre que de phosphore. Les différents sols ne contiennent pas les mêmes proportions de soufre; plus riches en soufre sont ceux qui renferment beaucoup de matière organique en décomposition. Il y a aussi un rapport entre le soufre que contient un sol et son origine géologique.

D'après Robinson (4), dix-huit sols dans l'est des Etats-Unis contiennent une moyenne de .04% de soufre, 800 livres à l'âcre.

Shedd (5) cite les résultats de l'analyse du soufre de dix sols du Kentucky, d'origine géologique différente. Il fait remarquer que les terres cultivées contiennent, et à la surface et dans le sous-sol, moins de soufre que les terres vierges de même origine géologi-

que et dans la même région. Dans les sols cultivés la somme de soufre, en livres par âcre, varie entre 500 et 1300 livres.

Hart et Peterson (3) montrèrent que: les sols normaux sont relativement pauvres en anhydride sulfrique. Un âcre-pied contiendrait de 1000 à 3000 livres de SO_3. Les terres cultivées durant 50 à 60 ans, non fumées ou légèrement fumées pendant cette période, perdraient, en moyenne, quarante pour cent de l'anhydride sulfurique présent au début, tel que trouvé par comparaison avec des terres en friche.

Brown et Kellogg (6) donnent les résultats de l'analyse du soufre dans des terres de l'Iowa; il y a des variations suivant les régions, mais aucune terre ne contient moins de 700 livres à l'âcre et aucune plus de 900. Le sol immédiatement au-dessous de la surface et le sol à la suite de ce dernier jusqu'à une profondeur de quarante pouces contiennent encore plus de soufre à l'àcre.

Les sources du soufre du sol sont: les roches sulfurées, la matière organique, le soufre apporté par la pluie et, dans les sols cultivés, le soufre ajouté avec différents engrais chimiques, tel que le sulfate d'ammonium, le sulfate de potassium, le superphosphate, le plâtre et le soufre seul.

Comme on l'a déjà dit, c'est sous forme de sulfates que le soufre est utilisé, quelle que soit la source dont il provient.

Soufre apporté par les pluies.

Il y a une grande variation entre les quantités de soufre contenues dans l'eau de pluie. Il y a en a plus dans l'eau de pluie des régions où il y a beaucoup de manufactures, de chemins de fer et de grandes villes. Tout charbon, surtout le charbon bitumineux, contient beaucoup de soufre et ce soufre s'échappe, par les cheminées, sous forme de différents gaz. Ces gaz s'oxydent rapidement dans l'air, se dissolvent dans l'eau de pluie qui les entraine avec elle. Ce sont donc surtout des sulfates que l'on trouve dans l'eau de pluie bien que l'on puisse quelquefois y découvrir aussi des sulfures,

Stewart (7) donne comme moyenne annuelle pour une période de sept années, 45. I livres de soufre contenues dans l'eau de précipitation d'une âcre de terre.

Hall, Hart et Peterson ont trouvé environ 7 livres de soufre dans les précipitations atmosphériques d'une année. Ames et Boltz (8) rapportent que Kossowitch trouva que la quantité de soufre, par âcre, contenue dans la pluie, variait de 9 livres en pleine campagne à 72 livres dans ou près des villes. Ames et Boltz croient que la pluie des Etats-Unis apporte une moyenne de 6 à 7 livres de soufre par âcre.

Disons pour terminer ce chapitre que les données sont pauvres et qu'il reste beaucoup d'ouvrage à faire pour connaître la quantité de soufre qui s'échappe dans l'air à la suite de la combustion du charbon, des fonderies, qui résulte de la décomposition des matières organiques dans les marais, etc. La quantité de soufre dans l'eau de pluie dépend de la quantité dans l'air. S'il n'y avait pas de soufre dans l'air le problème du soufre serait encore plus difficile à résoudre que celui de l'azote. L'analogie entre ces deux éléments est assez frappante: la réserve de l'un et de l'autre dans le sol est maintenue par la réserve de l'air et quand cette dernière source manque il faut y remédier par des engrais chimiques.

Soufre contenu dans les végétaux et soufre enlevé au sol par les récoltes.

Pour les raisons données plus haut, les chiffres indiqués ne seront pas ceux obtenus par la méthode de Wolff mais plutôt par la méthode au peroxyde de sodium d'Osborne ou par d'autres méthodes perfectionnées.

Dans les plantes, le soufre se trouve soit sous forme de soufre organique, soit sous forme de sulfates; tant qu'à la quantité trouvée, elle semble varier avec le traitement donné au sol. Shedd a constaté que les traitements sulfurés causaient une augmentation de la proportion du soufre dans les plantes, tant en ce qui concerne celle du soufre des sulfates que celle du soufre total.

Voici quelques chiffres qui indiquent la proportion de soufre dans les aliments.—Séchés à l'air.

Aliment.	Soufre total, pour cent.	Soufre des cendres.-Wolff. pour cent.
Foin de luzerne	.287	.170
Navets	.740	.359
Choux	.819	.527
Avoine	.189	.022
Paille d'avoine	.195	.092
Blé	.200	.002
Paille de blé	.119	.053

Soufre enlevé au sol par différentes récoltes:

Récolte	Poids sec; livres.	Soufre enlevé; livres.
Luzerne	9000	26.0
Navets	4657	36.9
Choux	4800	39.2
Avoine	3978	7.9
Blé	4083	6.3

En résumé, les récoltes les plus communes prennent des quantités de soufre variant entre 5 et 40 livres à l'âcre. Ce sont les céréales qui exigent le moins de soufre et les légumineuses qui en requièrent le plus (luzerne, trèfle) avec les crucifères (choux, navets).

Dans un grand nombre de localités c'est le phosphore qui semble être le facteur limite de la production des récoltes· Si nous comparons la quantité de soufre et de phosphore que contiennent les plantes nous trouvons que dans certains cas il y a au moins autant de soufre que de phosphore. Ames et Boltz rapportent que les crucifères contiennent plus de soufre que de phosphore et qu'ordinairement les céréales contiennent à peu près une fois moins de soufre que de phosphore. Et à la suite de comparaisons entre le soufre et le phosphore contenus dans le sol, Hart et Peterson, Shedd, Brown et Kellogg, et Ames et Boltz trouvèrent tous qu'il contient moins de soufre que de phosphore.

Soufre que contient l'eau de drainage.

La meilleure manière de connaître la quantité de soufre qu'entraîne l'eau du sol c'est par l'analyse des eaux de drainage dans les lysimètres.

Les nombreuses données obtenues à la suite d'expériences à l'aide de lysimètres à Rothamsted (9) indiquent une moyenne de 24.7 mg. de SO_3 par litre d'eau de drainage. (C'est plus de SO_3 que ce qui est apporté au sol par l'eau de précipitation).

A la station expérimentale de Floride on a trouvé 7.63 mg de SO_3 par litre d'eau de drainage. En se basant sur les données de cette station, Stewart estime de 20 à 80 livres la perte annuelle de soufre et il rapporte que l'on évalue cette perte, en Europe, entre 8 et 270 livres suivant le traitement donné au sol.

La perte de soufre dans l'Arkansas serait de 6 livres par âcre.

Lyon et Bizzel (10) croient que la quantité de soufre contenue dans l'eau de drainage des sols en friche est à peu près égale à la quantité contenue dans la récolte et dans l'eau de drainage des terres cultivées. Ils rapportent aussi que la quantité de soufre sous forme de sulfates dans l'eau de drainage est de trois à six fois aussi grande que celle de la récolte. La culture, suivant eux, ne serait pas un moyen de conservation du soufre.

Mais, d'un autre côté, Gerlach trouva le contraire.

Bilan du soufre dans le sol.

Tel qu'indiqué plus haut un âcre-pied de terre contient de 1000 à 3000 livres de SO_3, ou de 400 à 1200 livres de soufre.

A supposer qu'il n'y aurait pas de perte à la surface du sol et que les plantes utiliseraient tout le soufre, la plus petite quantité, à savoir 400 livres par âcre, ne suffirait qu'à la pousse de 15 récoltes de luzerne, 10 de choux ou 63 de blé.

D'après les données obtenues, il est évident que l'eau de pluie ne fournit pas assez de soufre pour compenser les pertes causées par les eaux de drainage. Il est vrai qu'un certain nombre de cultivateurs font des applications d'engrais chimiques ou de fumier; ce dernier fournit environ 3 livres de soufre par tonne, mais si c'est la seule source de soufre à laquelle on a recours, il est à peu près certain qu'il en résulte une diminution de l'approvisionnement de soufre qui devient un facteur limite de production· D'un autre côté, l'usage d'engrais chimiques peut être un bon moyen d'augmenter l'approvisionnement du soufre si l'on emploie comme engrais du sulfate d'ammonium, du superphosphate, du sulfate de potassium ou du soufre seul.

Quant à la perte de soufre par les eaux de drainage, il semble que Lyon et Bizzel sont justifiables de dire qu'à la vitesse suivant laquelle le soufre est enlevé par l'eau de drainage dans les lysimètres, il s'en trouve probablement une quantité insuffisante dans le sol après un certain temps.

En résumé, on en est encore à faire l'étude des relations entre l'approvisionnement de soufre du sol et les pertes causées par les plantes et les eaux de drainage.

Emploi du soufre comme engrais.

L'effet bienfaisant du soufre sur la crois-nce des plantes est connu depuis longtemps , pour ne pas remonter trop loin, citons les oservations de Marès. Marès considère le ufre comme une substance qui favorise la oissance des vignes, la fructification et qui tive la mâturité du raisin. Pour lui, il udrait classifier le soufre parmi les engrais.

Miège (II) a étudié l'emploi du soufre en riculture et il conclut: 'Qu'il faudrait por-r attention à ce nouvel engrais et éclaircir mportante question de l'emploi du soufre agriculture." Les enquêtes de Miège, edd, Lipman, McLean, Lint et d'un grand ombre d'autres qui s'occupèrent de la ques-on sont complètes et développées: aussi me ntenterai-je de ne citer que quelques-uns s ouvrages les plus importants et les plus cents, quelques noms seulement. Lierke it observer que l'emploi d'engrais conten-it du soufre, dans la culture fruitière, pro-it de bons résultats. Janicaud, Vermorel, oullanger, Chausit, Duley, Sherbakoff, Bos-elli, etc. etc., rapportent tous que de bons sultats furent obtenus grâce à l'emploi de ufre comme engrais.

Il existe, cependant, des comptes-rendus expériences où l'on n'attribue aucun résul-t et même des effets nuisibles à l'emploi du ufre.

Mais, si nous comparons les rapports fav-ables à l'emploi du soufre comme engrais ec ceux qui ne le sont pas l'on trouve que nombre de ces derniers est pratiquement égligeable.

Il faut se rappeler que des résultats néga-fs ont été obtenus sur beaucoup de sols et ec différentes récoltes dans le cas des dif-rents engrais chimiques. La préparation un engrais chimique basée sur des études npiriques tend à satisfaire les besoins d'un l particulier et pour une récolte donnée. ous ceux qui s'occupent du problème de mploi des engrais chimiques savent quel aspillage sont certaines pratiques d'engrais-ment du sol. Aucun système rationnel d'-graissement pour culture de la luzerne ne arlera d'applications de nitrate ou d'am-oniaque. Il faut se servir du même critère ans l'emploi du soufre comme engrais. Reimer et Tartar font justement remarquer que le soufre, comme tout autre engrais, ne causera pas une augmentation du rendement dans tous les sols. Il n'y a aucun doute que les résultats négatifs obtenus dans certains sols sont dûs à une balance convenable du soufre ou à d'autres facteurs, tel qu'il vient d'être indiqué.

Quelques opinions pour conclure.

Pour Stewart (7) le sol n'aurait pas besoin d'application d'engrais contenant du soufre parce que l'apport par les pluies serait suffisant.

Au contraire, Brown et Kellogg (12) prétendent que des engrais contenant du soufre doivent être appliqués au sol parce que la culture du grain ne fait qu'enlever du soufre au sol et que le fumier est appliqué en quantité insuffisante pour maintenir la réserve de cet élément.

"D'après les résultats obtenus au cours de nos expériences, rapportent Hart et Kellogg (3), il semblerait que pour obtenir une production permanente et toujours meilleure il faudrait inaugurer un système d'engraissement qui apporterait au sol, de temps en temps, en plus des éléments généralement reconnus comme indispensables, un quantité de soufre suffisante pour compenser les pertes dues aux récoltes et au drainage. Dans les conditions actuelles de l'agriculture, près des grands centres industriels, il ne paraît pas nécessaire d'ajouter de sulfates au sol, mais les districts agricoles éloignés de ces centres peuvent être pauvres en cet élément."

Avec le système d'élevage, là où la récolte et les aliments achetés sont donnés aux animaux et le fumier conservé, le soufre retourne au sol, mais il reste encore à savoir s'il ne faudrait pas compenser les pertes dues au drainage et au peu de soin que l'on prend du fumier. Avec le système de culture du grain, il semble qu'il faut ajouter d'une manière systématique, des sulfates sous une forme ou sous une autre dans le but d'y maintenir la réserve de soufre (13).

Toutes les notes et tous les chiffres de ce travail sont de l'étranger. On n'a encore rien fait sur cette question dans notre province.

Il me semble que nous pouvons croire que nos sols se trouvent, pour ce qui concerne leur teneur en soufre dans les mêmes conditions que ceux de l'est des Etats-Unis.

Notre système de culture mixte ou plutôt presque exclusivement d'industrie laitière nous oblige à dépenser la plus grande partie de nos récoltes sur la ferme et nous fournit l'avantage d'avoir une forte quantité de fumier pour l'engraissement de nos sols.

D'un autre côté, on ne suit encore à peu près nulle part de rotation, on utilise peu d'engrais chimiques, on conserve le fumier plutôt mal et, dans quelques régions, on cultive beaucoup de foin.

Il est donc possible qu'il manque du soufre dans certaines pièces d'une bonne partie de nos terres et dans certaines régions de la province.

Des recherches sur cette question feraient l'object d'un travail intéressant et peut-être plus utile qu'on ne le pense.

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"Esquisse géologique et Minéraux utiles de la Province de Québec."

Est la traduction française d'une élégante plaquette de 56 pages, rédigée par M. Théo. C. Denis, Surintendent du Service des Mines de la Province de Québec, pour l'exposition de Wembley en 1924.

Cette brochure, agrémentée de jolis clichés représentant des spécimens de minéraux et des sièges d'exploitations minières, commence par donner un bref aperçu des principales formations géologiques et des régions physiographiques que l'on peut distinguer dans la province. Ensuite elle nous fait l'historique de la découverte des principaux minéraux utile qu'on y trouve, parle de leurs applications en fait une courte description, s'arrêtant da antage aux espèces les plus importantes telle que l'amiante et les minéraux aurifères do les gisements récemment découverts dans région de l'Abitibi-Témiscamingue sont plei de promesses. Une carte géologique de province de Québec, mise au point d'après l dernières données, ainsi qu'une carte minéra accompagnent la brochure.

On peut se procurer celle-ci en s'adressa au Service des Mines du Ministère de la Co onisation, des Mines et des Pêcheries, à Qu bec.

ACTIVITES DES SECTIONS

Section de Montréal.

Le conférencier du diner-causerie qui a eu lieu 19 décembre fut monsieur Henry E. Lefèvre, Ingénieur agronome de l'Institut Agronomique de Paris et représentant du "Bureau de Propagande de la Société Commerciale des Potasses d'Alsace", à New York.

Monsieur Lefèvre fit l'historique de la découverte des fameux gisements de sels potassiques du bassin de Mulhouse qui étaient à peine en exploitation lorsque commença la guerre de 1914. De là, il passa aux mesures prises par l'administration française pour mettre graduellement en pleine valeur ces immenses richesses potentielles que recèlent les profondeurs de l'écorce terrestre dans cette région de l'Alsace reconquise Il faut remarquer, en effet, que l'Allemagne pour ne pas concurrences l'exploitation de ses anciens gisements de sels potassiques situés au centre du pays, n'avait pas poussé du tout la mise en exploitation de ces dépôts nouvellement découverts. Le conférencier fit aussi passer sur l'écran une série de clichés donnant des vues des travaux souterrains et des installations de la surface des principaux sièges en activité aux environs de la ville de Mulhouse. Ensuite, il nous montra encore un des grands camions automobiles avec matériel de démonstration dont se servant les agronomes au service du Bureau d'études de la Société Commerciale des Potasses d'Alsace, en France, pour vulgariser les connaissances sur le rôle des engrais et les méthodes de leur emploi, dans les campagnes.

M. H. M. Nagant, président de la Section de Montréal remercia vivement monsieur Lefèvre, qui avait bien voulu venir spécialement de New York pour faire cette intéressante causerie devant ses confrères du Canada. Il fit ressortir aussi que la propagande faite par le grandes organisations de producteurs d'engrais simples, telles que la Délégation des Producteurs de Nitrate de Soude du Chili, et la Société Commerciale des potasses d'Alsace, était réellement un travail parallèle à celui des agronomes officiels, parce que non seulement elles disposaient d' un personnel technique de premier ordre, mais que, de plus, elles savaient très bien que leur intérêt même était conforme avec la vérité scientifique et, en dernière analyse, avec celui du cultivateur.

A la fin de la séance une intéressante discussion se développa entre monsieur Lefèvre et plusieurs membres, concernant les moyens les plus pratiques pour opérer l'importation directe des sels potassiques de l'Alsace au Canada sans passer par l'intermédiaire des ports des Etats-Unis.

H M. N.

Nouvelles de nos membres.

On nous fait part du mariage de M. Moise J. Gagnon, I.A., pathologiste au Service de l'Horticulture du Département de Québec, avec mademoiselle Lucienne Pineault, fille de monsieur le docteur et madame J. Pineault, de Rimouski. La bénédiction nuptiale a été donnée à la cathédrale de Rimouski le jeudi 7 janvier 1926. Tous nos voeux de bonheur accompagnent les jeunes époux.

Nous sommes heureux d'apprendre le mariage de Monsieur Elzéar Campagna, B.A., B.S.A. professeur de Botanique au Collège d'Agriculture de Ste. Anne de la Pocatière avec Mademoiselle Fernande Talbot de cette même paroisse et qui a été célébré le 5 de janvier.

Tous ses confrères de la C.S.T.A. section Ste. Anne sont heureux d'offrir à leur dévoué secrétaire, Monsieur E. Campagna et à sa digne épouse leurs félicitations les plus sincères et leurs meilleurs souhaits de bonheur.

Concerning the C.S.T.A.

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Changing Viewpoints and Methods in Soil Classification.

A. H. JOEL

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My principle reasons for choosing this heme for presentation are as follows:

First, to direct your attention to new terms ind methods and modified points of view arisng from the findings of a number of comparatively recent investigations in soil science. Much of the subject matter is available in papers read and published at various soils conferences. However, most of it is not readily accessible, and I am therefore presuming that it is not common knowledge to most agronomists.

Second, to outline some of the broader relations and more important characteristics of the major groups of our soils as determined by field and laboratory investigations of the Saskatchewan Soil Survey. These will be considered principally from the standpoint of the newer viewpoints which I purpose to discuss.

Much of the information of the general plan of soil classification is taken from papers of Dr. C. F. Marbut, Chief of the Division of Soil Survey of the U. S. Bureau of Soils, and from various papers presented at conferences of the American Soils Survey Association. For assistance in gathering Saskatchewan data I am indebted to my colleagues, Prof. F. H. Edmunds and Mr. J. Mitchell.

The Need of An Effective System of Soil Classification

One of the fundamental needs of any natural science—in fact, one of its first requirements—is an effective system of classification of the bodies which it purposes to study. Such a scheme must not only be convenient and logical, but also very comprehensive.

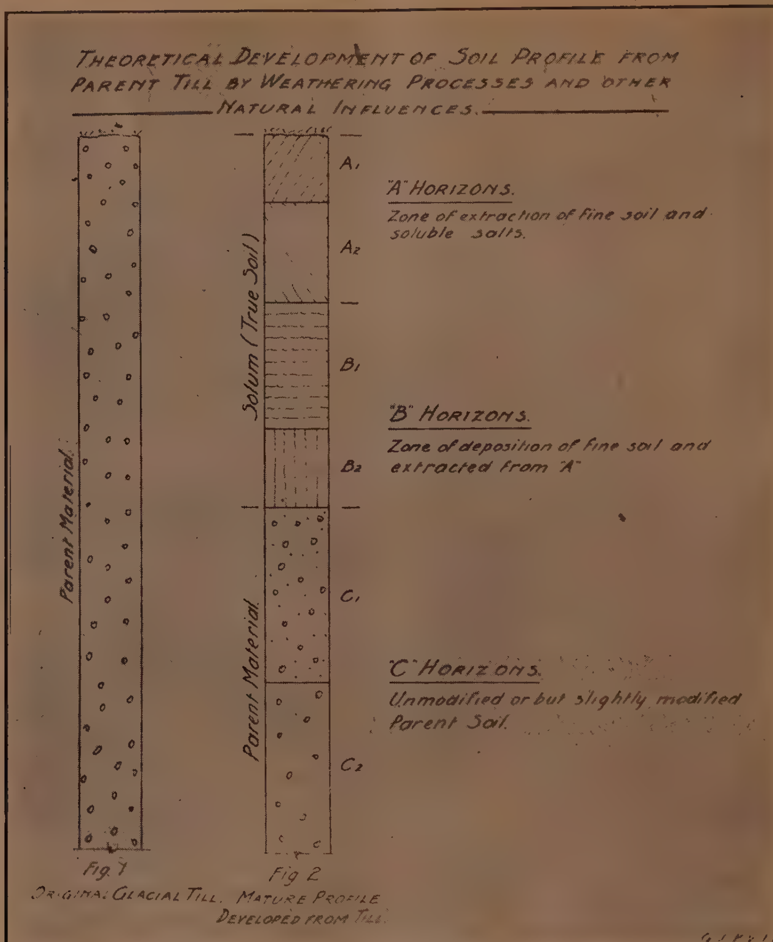
Botany, Zoology and many other natural sciences have long had such systems. Soils Science, however, has not yet developed a satisfactory classification that could be readily applied. One of the principle reasons for this, I believe, is the great difficulty in determining and evaluating the important characteristics to be used in differentiating soil groups and individual types. This is due to the complicated chemical and physical makeup of such a mass of material as is found in the soil body. Another reason for the lack of a satisfactory classification scheme is, no doubt, the comparative youth of the science.

Soils investigators have recently come to realize strongly the serious handicap of lacking a good classification key, especially when trying to apply the results of investigations in one part of the world to soils in another. Until quite recently they have managed with makeshift soil descriptions involving colorless and often quite meaningless terms such as soil, subsurface and subsoil, timber and prairie soils, humid and arid soils, etc., coupled with conflicting conceptions of colours and other soil characters.

Botanists and agronomists, may, with no great effort, obtain a comprehensive description of a plant if given its scientific name. Soils men lack such a key. We need a Rydberg or a Gray.

The International Society of Soil Science has keenly felt the need of an effective classification in its various conferences, and recognizing the bar to the progress of Soil Science, special international committees were appointed to work on the problem. The valuable contributions of the committees of the Fourth Conference held in Prague, Czechoslovakia, in 1922, and of the Fifth, in Rome, in 1924, represent great strides of progress in the solution of the problem. A very promising foundation scheme has been established and generally agreed upon. Since the Rome conference a great deal of work has been carried on, and will be intensively pursued during the coming year. This is in preparation for the elaborating and building up of the proposed system of soil classification, with the intention of presenting and moulding it at the Sixth International Soils Congress to be held at Washington, D.C., in May, 1927. Field

* Paper given before the Western Canadian Society of Agronomy, Saskatoon, Sask., December, 1925.



workers, especially, are giving the problem considerable attention, collecting a great mass of data, numerous samples, pictures, etc. As one immediate outcome of this international effort it is planned that the special committee will present the first reconnoissance soil maps of the world and of the continents at the coming conference. In short, pedologists are, at present, greatly concerned with the study of the fundamental characteristics of soils. We want to become really well acquainted with the character of the natural body with which we are concerned. It seems to be the concensus of opinion that this should take precedence over many other studies previously pursued.

The Inadequacy of Recent Popular S… Classification Systems

Most natural science classifications a… based on the characteristics of the obje… or bodies studied. Soil classifications, … the other hand, have been based mainly … external modifying factors such as geologic… origin and climatic and vegetative influenc… It is not my purpose to discuss the reaso… for this. However, I do wish to outline bri… ly the reasons why such bases are illogic… and generally unsatisfactory and are cons… quently giving way to a scheme based prima… ily on soil characteristics. This comple… change is the principal newer viewpoint … which I wish to call your attention.

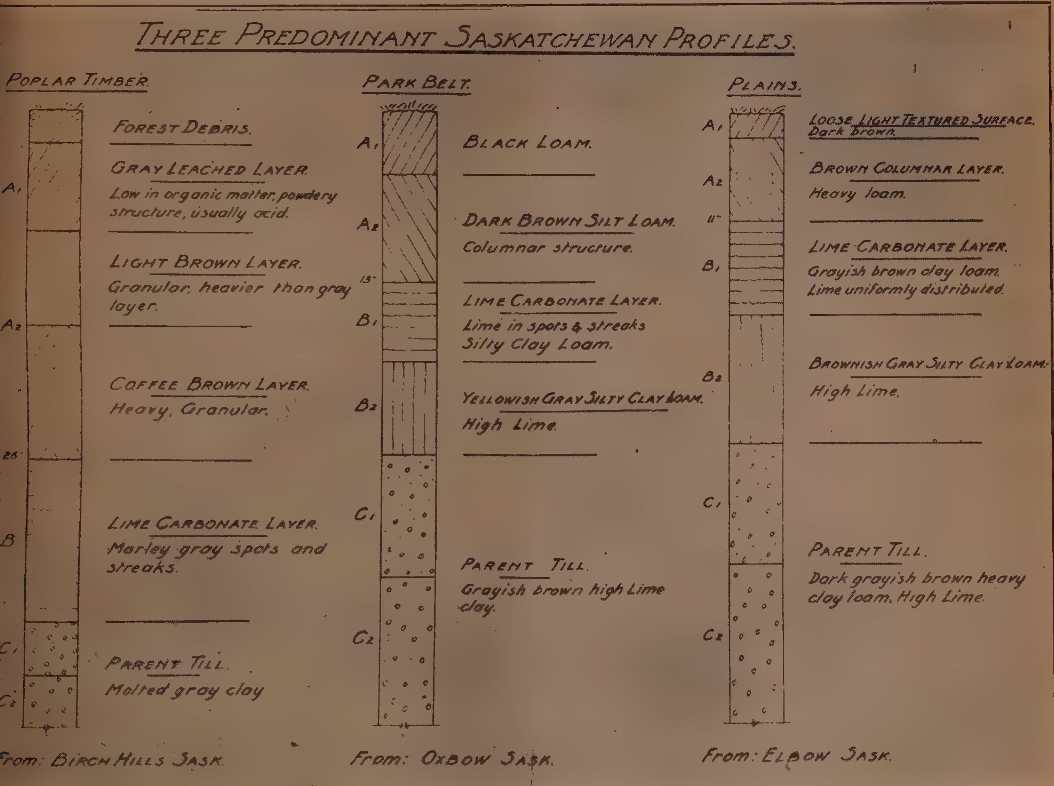
Classification based on geological origin … one of the first and most popular in use. Th…

ıs probably a natural result of the close lationship of soils to Geology and of the rlier work done in the latter science. The heme has been very useful, but, as is true other methods based on external factors ther than on the inherent characteristics of e soil itself, it has proven inadequate for neral application. In studying local areas e scheme worked fairly well, but in study- g separate groups many of the relationships soil features and geological origin failed hold good.

To illustrate, in Saskatchewan the unsorted oulder clay or glacial till plain deposits are e original or parent materials from which ost of our soils developed. Even at idely separated points this material posses- s a number of identical characteristics, and the same local area the unmodified till is ually very much the same wherever found. urthermore, in these local areas the derived ils are as nearly alike as their "parent" mat- ials or the original till deposits. Conse- ently, in such restricted areas the geological scheme works very well. On the other hand, in widely separated areas, soils derived from similar glacial till are often very dissimilar. The geological system usually falls down when applied to separated districts.

Another basis of classification commonly used has been that of climate. It too has been found wanting, but in a different way. It has proven to be a far more effective basis than the geological in making broad groupings, but is a poor criterion for soil classification when used for local separations.

For example, our prairie province soils are in an entirely different class than Ontario soils. In fact, the separation is so marked that we have no fear of duplicating names for the same soils in both places. Furthermore, we know that climatic differences are chiefly responsible for the soil differences, that our prairie province lands are made up of sub-humid and semi-arid soils and that Ontario lands are made up of humid soils. These differences between these two great groups are always well marked as I shall



later illustrate. However, within each area mentioned, there are many variations that cannot be accounted for by climate. This basis, therefore, is of little use as a common basis for separations, in local districts.

Still another basis of classification commonly used is that of natural vegetation. I shall dismiss it with a few general considerations. Suffice it to say that although it, too, has been a useful guide in explaining many soil features, and in separating broad groups, it is too limited in application.

In our field work we have observed some interesting ecological relations. In fact, in many cases the plant and soil associations have helped us considerably in mapping our types. For example, in South-east Saskatchewan, South of Oxbow, in a certain area belts of sand or gravelly soils were distinctly marked out from the loam areas by the absence of "bluffs" (clumps of willow, poplar, etc.). In fact, in the whole district there seems to be a gradual encroachment of this typical Park Belt growth over the medium soil types. In other districts Golden and Black Willows usually mark out poorly drained spots; Rose, Wolf Willow, Snow Berry, Wild Cherry, and others, the light well-drained lands; various salt bushes, the alkali spots, etc.

The most striking general separations are between the prairie and the timber soils. In all parts of the world soils developed under these two conditions present distinctly different characteristics, and many interesting soil features have been explained on this basis. Still, the differences in vegetation will not explain many variations either in the same local area or in separated belts.

The Soil Profile as a Basis for Classification

The various schemes of classification mentioned have all proven inadequate for various reasons. It has therefore been necessary to remould old viewpoints completely, and to make a more direct attack. The basis chosen by the special International Committees appointed for the purpose is that of actual soil characteristics as determined by studies of the soil profile.

By the soil profile is meant the complete vertical soil section to a point well within the unmodified parent or original material from which the natural weathered soil has been developed. This manner of approach d directly with the soil itself and not with ternal causative factors or associations. bases the classification on the evolved pro rather than on the various factors which termine the course of the evolution.

Most agronomists are very likely fa liar with the soil profile in a general way am assuming, however, that they not so familiar with its details, special te and application. I hope that this is not ing too much for granted.

A common characteristic of a normal developed soil profile is the layered or tie arrangement. The various natural lay known as horizons, seem to be the final p duct of the various factors involved in s development: climatic, vegetative, geologi origin, etc. The significant facts are that herein have a property common to practica all normal soils, yet inherently different details in different soil types, with these d ferences representing the results of vary development, as well as variations in fun mental features.

The general character and theoretical velopment of the most representative type Saskatchewan profile or soil section is ill trated in the chart on page 226.

Figure 1 in this chart represents a prof of upland glacial till as originally deposit in this general vicinity by the ice sheet su posedly about 25,000 years ago. By far t greater portion of Saskatchewan surface posits originated in this way. The origin soil deposit was very likely a heterogene mass of rock material ranging in size fr large boulders to colloidal clay. We ha reason to believe that this material is s well preserved in an unmodified or ve slightly modified condition underneath t weathered portion of the soil column, g erally below a depth of about 6 feet.

During the centuries intervening betw this deposition and the present, a number processes have been slowly but steadily cha ing this heterogeneous mass of material i our present soil profile and its definite ho zons. The repeated percolation of wa through the column has extracted much the finer soil particles and soluble salts fr the top layers and deposited them in lay

A road cut in the short grass plains area of Saskatchewan. The dark A horizons, the well developed lime layer—B horizon—and the characteristic columnar structure are all clearly shown.

below. The accumulation of organic residues and their subsequent decay has radically changed the layers affected in their physical and chemical properties. Chemical reactions of great number and complication have also left their stamp. As a consequence of these and other modifying influences the general type of soil column illustrated in Fig. 2, has been developed from that shown in Fig. 1. The two roughly represent the genesis of the soil profile.

Four general divisions are usually present in the natural profile of a normally well developed soil. The first, not always considered as a part of the profile itself, is a layer of surface organic residue which I have arbitrarily labeled as O.M. This is typically a very thin layer on prairie soils, but often as thick as one foot on some forest soils. Second is a section beneath this O.M. known as the A horizon, representing the zone of extraction or eluviation. Beneath the A horizon is a zone of accumulation or concentration, the B horizon. Finally, at the base of the profile is the zone of unmodified or but slightly modified original soil material, known as the C horizon. The surface organic matter accumulation with the A and B horizons constitute the true soil. The International Committee on Classification has chosen to call it the "Solum" and the original geological deposit the "parent material".

Most soil profiles show a more detailed division of zones based on differences in colour, structure, texture, etc. The subdivisions most generally found are known as the A_1, and A_2; B_1 and B_2; and C_1 and C_2 horizons, and the term horizon usually applies to these subdivisions rather than to the principal zones.

A normal or mature soil profile is considered to be that profile developed on well-drained, smooth uplands, in virgin soil, and under conditions where the soil has been undisturbed for a long period. In other words, it should represent the well oxidized, well aerated. well-drained and deeply weathered soil column of the region. Such conditions are considered essential to the development of normal agricultural soils.

Immature or imperfect profiles are the abnormally developed or poorly developed types such as are found in recent deposits of streams, on slopes where repeated erosion and deposition destroy the profile, in poorly drained areas or under other conditions where erosion, youth or insufficient or excessive drainage have prevented the normal and complete action of weathering processes over long periods of time. On this basis extremely light and extremely heavy soils are not considered as having normal profiles. The mature profile is taken as the standard of the region and the other types described by comparison to it.

The terms soil, subsurface and subsoil, are practically in discard unless used with definite terms to locate them in the profile.

The principal differentiating characteristics used in soil classification on the basis of the profile are as follows: the number, colour, texture, structure, chemical composition, thickness, relative arrangement, resistance to penetration and consistency of the various horizons and the geology and nature of the parent material.

Great World Groups of Soils Based on Profile Separation

Based on this general scheme the soils of the world have been divided into a number of great groups; and, where extensive work is being done in soil surveys, subdivisions have been made into minor groups. Possibly the final arrangement will be quite similar to Zo-

ological divisions, classes, orders, families, genera, species and varieties.

To illustrate its application I shall briefly describe and illustrate four profiles representing as many world groups of soils. At the same time I shall point out how these major groups may be subdivided into minor groups representing some of our own Soil Series and Types.

Soils of the world may be divided into two great groups on the basis of the presence or absence of a zone of accumulation of lime carbonate and salts of alkali and other alkaline earths. Our soils are in the group in which the zone is present. This feature is peculiar to dry climates, ranging from subhumid to arid. You have no doubt all noticed the layer in road cuts, deep plowing, holes, etc.

This lime layer represents a zone of deposition or accumulation of salts, the greater portion of which are leached out of the A horizons by percolation water. The probable reason for its concentration in this particular zone is that the quantity of percolation water is so limited that the depth of penetration is usually within this zone. The salts simply precipitate out of solution. In humid regions, on the other hand, there is sufficient water to form an almost constant percolation flow right through the soil column. Under such conditions the salts are finally leached away as seepage water, and the zone of concentration does not form.

This zone of salt accumulation may easily be determined by the effervescence reaction of dilute HCl with the lime carbonate, the liberated CO_2 gas forming the bubbles. The layer is usually of a marly gray color. The salts may either be quite uniformly distributed in the layer or concentrated in granules or streaks. Another characteristic feature of most dry land soils is the presence on the surface of a thin layer, often a mere film in thickness, of light textured loose soil of single grain structure. It resembles wind-blown material and may have such an origin.

Still another feature is a characteristic type of structure in the A_2 and B_1 horizons. This is a columnar arrangement, rather poorly shown in the pictures.

The humid climate profiles are characterized not by a zone of salt accumulation but by a zone of accumulation of fine soil particles.

Both salts and fine soil material are removed from the A horizons, but only the soil particles are held back by the filtering action of the B horizons. Two important profile features result from this action. One is the change in texture of the zones of extraction and of accumulation, the loss of fine particles leaving the A horizons lighter textured (sandier), and the addition of fine particles to the zone of accumulation making the B horizons heavier. This probably accounts for the heavy subsoils of most humid areas. The other feature produced by this strong leaching action is the much lower content of lime and many other mineral salts in the Solum of humid soils as compared to "dry" soils. The great prevalence of soil acidity and the absence of alkali conditions are two important practical results.

In humid soils then we have intensive extraction of fine soil from the surface layers and of salts from the whole profile. The A horizon then is light textured and the B heavy textured. The same general differences of colour resulting from variations in organic matter occur as in dry land soils.

Fine soil particles may also be transferred in dry land soils and generally are under our conditions, but to a lesser extent.

Here then we have two broad groups of soils based on fundamental differences in profiles. True, the contrasts are due principally to differences in climate, yet the classification is based not on climate but on profile characteristics alone.

Two other major soil separations may be made on the basis of two distinctly different profile types. These correspond generally, to our so-called timber and prairie soils. The profiles are in strong contrast, especially in the upper layers. We have both here in the west. The real timber profile, however, is quite limited in occurrence. As is true of two profiles just described, a study of the horizonal characteristics serves to explain a number of peculiar soil conditions.

The timber profile developed under northern conditions in Russia—the so-called podsol type—seems usually to possess an organic accumulation of forest debris only slightly decomposed, usually acid in reaction and brown

in colour. Just beneath is a layer of light textured, light coloured soil, usually acid in reaction, low in organic matter and badly leached. Below this is a heavier layer, yellowish brown to coffee brown in colour, the zone of accumulation of fine particles, the B horizon. The layer of salt accumulation may or may not occur depending on climatic conditions. In Saskatchewan it practically always does, although at lower depths than in prairie soils.

Many of our poor, so-called burnt-over and white-mud northern bush lands are very likely soils of the profile just described, though not so well developed as the Russian podsols. The surface organic matter soon disappears. The white-mud appearance is merely the badly leached light coloured A horizon. It composes most of the plough-depth surface soil. Its acid reaction, low organic matter and leached condition explain its low productivity and poor physical state. The excessive leaching in this layer is likely due to the presence of organic acids in the percolation water, such acids forming in the layer of leaves, moss and other forest debris on the surface.

The Park Belt lands should not be included in forested soils. They are an entirely different proposition as I shall later point out.

The last major profile which I wish to consider is that of the treeless type. It also may or may not have the lime layer present, depending on climatic conditions. Under our conditions it is practically always present in mature profiles; on the humid corn belt prairie it is not.

In this group there is little or no accumulation of undecomposed surface organic matter, such as was pointed out for forest soils. On the other hand there is an accumulation of well decomposed organic matter in the A horizons and sometimes in lower layers, the quantity usually decreasing with depth. The gradual change from darker to lighter shades of colour from surface to subsurface horizons, the result of differences in organic content, is one of the most characteristic features of prairie profiles.

Saskatchewan Profiles and Their Interpretation

The most prevalent type of Saskatchewan profile combines the prairie and semi-arid features, namely, decomposed organic matter in the top layers, decreasing in quantity with depth; a thin surface layer of light textured loose soil; a definite layer of salt concentration; columnar structure, especially of the A_2 horizon, and a compact heavier horizon beneath the loose surface layer, also generally the A_2 horizon.

A number of soil relations and peculiar soil conditions in Saskatchewan may be at least partially explained and interpreted on the basis of profile characteristics described. For example, the nature of the Park Belt profile strongly indicates that in most cases, at least, this belt was originally prairie and that the tree growth has encroached upon it quite recently in soil history. I am still more convinced of this after interviewing early settlers in a typical park area during this past summer. All agreed that the Park "bluffs" had come in since their arrival and that previous to cultivation the whole area was open prairie. At present much of this district supports quite a dense growth of mixed poplar and willow, with open prairie between the bluffs.

Had the opposite condition been the case—that is, an original forest belt thinned out to present Park conditions,—I dare say that this very fertile black land belt would hardly measure up to its present productive power.

Another conclusion which seems reasonable is that our various prairie profiles are fairly accurate records of climatic conditions in various parts of our province for a long period of years. Under humid conditions the A horizons of upland prairie soils are usually dark brown to black in colour and a definite layer of salt concentration absent. On the other hand, under desert or arid conditions, the surface layer is usually very light brown to grayish brown in colour, with the zone of salt concentration right at the surface. In Saskatchewan, as well as in other areas of similar climate, it has been noted that the gradation in surface colour from light brown to black and the increase in depth of the layer of salt concentration both vary quite consistently with changes in climatic conditions which tend to increase the quantity of effective soil moisture. In short, the surface colours tend to darken and the salt layer to become deeper as the quantity of available soil moisture is increased. The changes agree pretty well

with long time rainfall records coupled with evaporation observations.

It seems reasonable to assume from this, that these profile features furnish us not only with valuable bases for soil classification, but also with average long-time meteorological records at least as accurate as many records of geological history as interpreted from rock formations.

Other conditions which may be at least partially interpreted from a study of soil profile features are the acidity of our northern "bush" soils, the presence of hardpan layers, the relative age and amount of leaching of lands, drainage history, etc.

However, the real purpose of soil profile studies at present is not to explain soil conditions so much as to develop a good scheme of classification. The interpretative work is at present secondary to the work of classifying.

Soil Sampling by Profiles

Many changes of methods of studying soils, both in the field and laboratory, have been necessary in order to conform with the profile system of classification. Most of these directly concern the soils man. I shall limit this phase of my discussion to one proposition, namely that of soil sampling. This matter concerns anyone dealing with soils to any appreciable extent.

In brief, in my own humble opinion, I believe that, in general, samples should be taken by profile layers rather than by arbitrary depths. The former method gives both the sampler and examiner a great deal more information of the particular soil dealt with. Furthermore, the results of horizon analysis and of other profile studies may generally be interpreted in terms of arbitrary depths, but similar information on the basis of arbitrary depths is seldom applicable to profile layers. For example, analyses made of the A and B horizon of known thicknesses may be easily calculated to depths of 0-6 2/3 and 6 2/3 to 20 inches, the usual depths selected, and recent studies have shown that such calculations usually approximate the results of actual analyses.

As to the actual sampling process a wide bladed pick and a shovel and post hole digger have proven to be far more satisfactory than the soil auger. In fact the auger has lost favour considerably with soil surveyors. It is still used by the field parties, but usually not as the principal sampling tool. The pick, shovel and post hole digger expose the complete soil profile and enable one to take more accurate samples without seriously changing the soil structure or mixing chemically and physically different layers.

C.S.T.A. STUDENT MEMBER WINS CASE ESSAY CONTEST.

To W. C. Wood, an Agricultural Engineering student of the University of Saskatchewan, goes the honour of winning the essay contest staged by the J. I. Case Threshing Machine Company of Racine, Wisconsin, on the subject of "The Advantages of Tractor Farming". This contest was open only to Junior and Senior agricultural students majoring in agricultural engineering, in any college or university in the United States or Canada. Entries were received from all sections of the country, clearly indicating the keen interest that these students are taking in power-farming.

The second prize was awarded to Edwin M. Cupp, a student at the Ohio State University, and the third prize to Fred A. Lyman at the Iowa State College.

W. C. Wood

Segregation in Aberrant Sweet Clover Forms.

LAWRENCE E. KIRK

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In 1924 certain peculiar plants of sweet lover parentage were found in a field of Arcic sweet clover on the experimental farm at askatoon. These were described with illusrations in Vol. V. No. 4 of *Scientific Agriculure.* The progeny of some of these plants hich were grown in 1925 are of such ature as to interest considerably those who aw them. Numerous requests for informaion seem to justify another reference to their ehaviour.

The mother plants differed from typical weet clover in many respects. While no one ould question their relationship to sweet lover, the aberrant forms were strikingly diferent from the latter in one or more importnt respects. In habit of growth the abnoralities included constricted branching, tuftd foliage, numerous primary stalks and well eveloped much branched crowns. The inorescence was sometimes characterized by hortened racemes, bunched flower clusters or longated flower pedicles. In one case flower lusters were produced on branches growing ut from what would normally be the axis f the raceme forming an inflorescence pyraidal in shape and feathery in appearance. he pods, when produced, were usually noral in appearance but in a few cases they ere long, narrow, slightly coiled and with our to five ovules in each.

Several of the forms were completely stere and others nearly so. The only fully ferle and heavily podded plants were those ith numerous primary stalks and well deeloped crowns. Some seed, however, was ecured from a considerable number of the artially fertile plants.

In the spring of 1925, seed from ten selectd plants was germinated in the greenhouse nd 34 seedlings from each were transplantd into the field early in June. Owing to the avourable season all of them lived and made n exceptionally large growth. Thirty-four lants of typical sweet clover were grown for omparison.

* Paper given before the Western Canadian ociety of Agronomy, Saskatoon, Sask., December, 925.

Six of the ten families showed segregation within the progeny into two distinct types. Each of the segregating families were quite distinct in many ways but the two types into which they segregated had essentially the same habit of growth in each case, one group of plants being similar to typical white sweet clover, and the other characterized by greater leafiness, numerous stalks and a well developed much branched crown. These two types of segregates we shall designate as "sweet clover" and "aberrant" respectively.

The well developed crown with its numerous leafy stalks was the characteristic thing about these aberrant segregates. The seedlings could be distinguished on this basis when only three or four inches high. They could be recognized in the field at a distance of many rods. Examination of the crowns in the fall showed the usual shoulder buds to be absent, their appearance being similar to those of alfalfa. Roots taken into the greenhouse in November produced a wealth of shoots in alfalfa fashion.

Typical sweet clover and aberrant segregates occurred in the following proportions:

Number of Family	Sweet Clover Segregates	Crown Segregates	Doubtful
1	11	21	2
2	6	27	1
3	10	24	0
4	8	25	1
7	18	16	0
8	13	20	1

Many of the sweet clover segregates and an odd aberrant segregate produced a few flowers. In all cases the blossoms were similar to those of white sweet clover. It was also observed that the leaf type varied from those having deep serrations to others with smooth margins. Marked differences were evident in the taste of the leaves. Many plants were classified on the basis of a chewing test and it was found that the sweet clover segregates almost invariably possessed the charac-

Typical sweet clover and aberrant types of segregating plants from families No. 7 (upper), No. 3 (center), and No. 8 (lower). First year's growth. Plants photographed in the field July 27th, 1925.

teristic sweet clover taste while it varied with the aberrant segregates from considerable to almost complete absence.

Pictures of plants often convey a better impression of their appearance than words. Typical plants of the two types of segregates from each family were photographed in the field on July 27th and a few of the aberrant segregates again on August 13th. Some of these are reproduced herewith. All are comparable as to size.

It was suggested for certain reasons in the previous article that the aberrant sweet clover types might possibly be natural hybrids, alfalfa being the other parent. This conjecture may or may not be correct, but it is an interesting speculation and one that seems to me not less plausible after having observed the progeny of the mother plants during the past season.

Next year's growth, if the plants survive the winter, will be more instructive than that of the first year as it will then be possible to observe their flowering and seeding habits. We plan also to grow a much larger population of the families which have proven most interesting this year. A number of other aberrant forms will also be investigated which have not yet been worked with.

Typical aberrant segregates from families No. 4 (upper) and No. 8 (lower). First year's growth. Photographed in the field, August 13th, 1925.

SEED AND SOIL INOCULATION AND ITS LIMITATIONS

With cultures of various sorts on the market, both for legume and non-legume inoculation, the farmer is often at a loss to known to what extent the practice of inoculation is based on sound principles, and to what degree he may reasonably expect success. The practice of inoculating the seeds of leguminous plants has been carried on for over twenty years, and has been shown to be of distinct value in a large number of cases. Bacteria developing in the root nodules of leguminous plants are able to utilize nitrogen from the atmosphere, and make it available to the growing plant. Many soils, especially in districts where particular legumes are being cultivated for the first time, are deficient in nodule bacteria, and adding these bacteria, either by inoculating the seed with culture before sowing, or by introducing soil from a field which has grown the crop successfully, has been proven to be a beneficial practice.

Up to the present, however, seed and soil inoculation with other than legume cultures has not been placed on a sound basis, or received support from agricultural scientists. From time to time, cultures under various names have been prepared, claiming to be of value in cultivating non-leguminous crops, but so far, none of these have been shown to be of definite value. Experiments conducted on the Experimental Farms with two such cultures, namely "Soilgro" and "Soil Vita", have failed to show results which would indicate any practical benefit to be derived from their use. Extensive Laboratory tests showed the cultures in question to possess no advantage over ordinary soil, as far as the bacteria contained were concerned, while tests on a variety of crops gave negative results. The reason that little can be hoped from such cultures is that the bacteria which play such an indispensable part in the preparation of plant food are, with the possible exception of the legume bacteria, already present in an otherwise good soil. If they are lacking in a soil, soil conditions do not favour their growth, so that adding bacteria, other than legume bacteria, will be superfluous in normal soils, and of little avail in abnormal soils.

Legume inoculation is to be encouraged, though it should be pointed out that it is only one of the factors concerned in successful legume production. Success will be most probable if the other soil conditions are at their best, inoculation being an aid to, but by no means a substitute for, good farming methods.

A. G. LOCHHEAD,
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New and Old Silage Crops and Silage Methods Tested at the Dominion Experimental Station, Lacombe, Alta.

G. E. DE LONG

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Factors Influencing Silage Crop Production

For the information of those who are not familiar with conditions that obtain in Central Alberta with respect to factors which have a bearing on the production of silage crops, it might not be out of place to give a short outline of the climatic limitations, soil conditions, etc., that are related to the subject under discussion.

The immediate problems in silage crop production are nearly all the result of climatic limitations. The climatic factors which exert the most influence are temperature and precipitation. These, along with other meteorological data, are presented in Table 1.

The annual precipitation varies from 21.84 inches in 1911 to 12.415 in 1920, with the average annual precipitation amounting to 17.22 inches. Fortunately over seventy-six per cent of the precipitation occurs during the growing season. It can readily be seen that during years with the amount of rainfall below the average such as was the case in 1920 crops which grow best under moderately humid conditions will not make a normal growth. Oats seeded in the regular way are a very poor silage crop in years with limited precipitation.

The table below does not give the date of the late spring and early fall frosts. Frost occurred every June with two exceptions and every August with six exceptions since meteorological records were started. These late spring and early fall frosts make corn a very uncertain crop, and are a factor to be considered in selecting suitable silage crops for Central Alberta.

Most of the soil of Central Alberta is a dark loam, is very productive, and provides no limitation in silage crop production.

The topography of the district consists of a series of broad fertile valleys which become broader and shallower towards the east until the open prairie is reached, while towards the west these valleys become narrower and the land rougher as the foothills grade into the mountains. Bluffs of light willow and Buffalo brush start on the outer margin of the

TABLE 1.

Summary of Meteorological records at the Dominion Experimental Station, Lacombe, Alberta, for the months of April, May, June, July, August and September, for the years 1908 to 1924, inclusive.

Month	Average precipitation Inches	Per Cent of yearly precipitation Percent	Average sunshine duration Hours	Average monthly mean temperature	Average monthly maximum temperature	Average monthly minimum temperature
April	1.21	7.03	202.8	36.69	70.25	8.6
May	1.87	10.86	229.0	48.28	80.05	18.3
June	3.44	19.98	254.2	55.75	74.4	27.8
July	2.88	16.72	290.6	59.52	87.18	33.99
August	2.40	13.94	257.7	58.05	86.9	31.6
September	1.43	8.30	196.8	48.75	81.4	21.8
Yearly average	17.22					

* Paper given before the Western Canadian Society of Agronomy, Saskatoon, Sask., December, 1925.

rairie and gradually grade into poplar and eavier timber northward and westward to-ards the mountains.

There is no Ideal Silage Crop for Use in Central Alberta

That there is a silage problem is very ap-arent from the discussions one hears among ockmen of the district. These discussions ndicate the same problems encountered by e Experimental Station in the production f four to five hundred tons of silage per ear.

Three silage crops, sunflowers, oats and orn, are used by the Experimental Station. ach of these crops has both good and bad oints as indicated in the following para-raphs.

The ability of sunflowers to withstand eight o ten degrees of frost without serious injury, nd to produce a larger tonnage of green eight per acre than corn or oats, make them he most dependable of the three. While the ilage produced from sunflowers is usually be-ow corn and oat silage in feeding value and alatability, it nevertheless is a nutritious ilage that is eaten with relish by the cattle ept at the Station. It is the writer's opinion hat, because they can be depended on to pro-uce big tonnages per acre, the stock man ould be well advised to use sunflowers for t least one third of the silage he will require. he disadvantages of sunflowers as a silage rop are the lack of quality and palatability f the silage; the tendency of the silage to reeze badly in the winter; and the fact that e sunflower crop does not leave the land as good condition with respect to moisture nd plant food as other intertilled crops.

Corn is a risky silage crop for Central Al-erta. Our late spring and early fall frosts requently do this crop considerable injury. he growing season is so short that nothing ut the very earliest maturing varieties can e depended upon to mature sufficiently to ake sweet silage. The result is that a slight- acid silage is usually made from corn even hen the most approved silage practices are ollowed. The chief failings of corn as a silage rop are its succeptibility to frost injury and e fact that it produces comparatively low ields in cool seasons. With the advent of ewer and improved varieties the possibili-ties of corn as a silage crop are improving, although considerable improvement is neces-sary before one would be justified in depend-ing on corn exclusively as a silage crop.

Oats have many good points as a silage crop. They produce the best silage used at the Experimental Station; no special mach-inery is required to handle the crop; every farmer has his own seed; green oat sheaves are handled much easier than corn or sun-flowers, both in the field and at the cutting box; while the cost of production is fre-quently lower than that of the other two silage crops. The only fault that can be found with oats as a silage crop is that they lack the ability to produce sufficient tonnage in a dry season when an abundance of sil-age is most needed. This factor alone is suf-ficient justification for the elimination of oats as the exclusive silage crop.

The Problem of Silage Crop Production

The problem in experimental work with silage crops is to find a crop or combina-tion of crops that is not subject to injury from late spring and early fall frosts, and one that will also produce silage equal in tonnage to sunflowers and equal in quality to good corn silage.

Certain Experimental Stations have found that a mixture of sunflowers and oat green-feed produced a silage very superior in qual-ity to pure sunflower silage. This practice, however, has never come into universal use among farmers for the reason that it is fre-quently difficult to put into operation. It necessitates building stacks adjoining the site of the cutting box or having two wagons un-loading at the same time. Frequently both of these methods are out of the question as a result of the location of the silo. Alterna-ting the sunflower and oat greenfeed loads usually results in an imperfect mixture of the two crops.

It seemed to the writer that the difficulties encountered in mixing sunflowers and oats might be overcome by growing the two crops in combination. With this in mind the fol-low preliminary experiment was outlined and started in 1925.

The results of the field work in connection with this experiment are presented in the fol-lowing table:

TABLE 2.

Oat and Sunflower Mixtures for Ensilage

Percentage mixture of seed.	Height inches	Date of cutting	Yield per acre green weight	Per cent dry matter	Yield per acre dry matter
			lbs.	per cent	lbs.
Oats 100%	39	Aug. 31	12,220	25.48	3114
Oats 75%; Sunflowers 25%.	44	Aug. 31	23,400	18.55	4340
Oats 50%; Sunflowers 50%.	47	Sept. 10	28,275	19.63	5550
Oats 25%; Sunflowers 75%.	50	Sept. 10	30,065	13.57	4081
Sunflowers 100%..........	54	Sept. 10	44,460	11.91	5295

Banner oats and Mammoth Russian sunflowers were the varieties used in this experiment.

The different mixtures were seeded thickly in rows 36 inches apart on May 31st and were harvested on August 31st and September 10th. They were given the cultivation necessary in keeping weeds under control.

It will be noted there is a gradual decrease in the height of the crop as the per cent of oat seed is increased; that the addition of 25% sunflower seed caused a rapid increase in the yield of green weight per acre and that there was a gradual increase in the yield of green weight per acre as the per cent of sunflower seed was increased; that the dry matter content decreases as the per cent of sunflower seed increases; that the yield of dry matter per acre is highest where the 50-50 mixture is used; and that there was a gradual decrease in the height of the sunflower plants as the percent of oats in the seed mixtu was increased.

The crop produced from the different see ings was ensiled in small experimental sil on the dates given for cutting. It will noted that the oats and the oats 75% and su flowers 25% mixture were ensiled ten da earlier than the other mixtures and the su flowers. The explanation is that on this da the oats in the first two plots had matur sufficiently that it was thought inadvisable leave them longer without ensiling, whi there appeared to be sufficient sunflowers the other mixtures to supply sufficient mo ture for the development of a good silage the oats were allowed to attain greater matu ity. The oats were in the early dough sta on August 31st, and in the firm dough sta on September 10th. In all cases the sunflo ers were immature with no blooms showin

These small experimental silos were ope

FIGURE 1.

Oat, oat-sunflower mixtures and sunflower test rows as they appeared on August 10. It will be noted that the oats made a more rapid growth than the sunflowers up to this point.

and sampled on November 4th. The sil- taken from each silo was weighed and shrink in weight as a result of fermenta- and drainage losses estimated. These es were as follows:

ixture of Seed	Shrink of Silage in Silo
s	9.6%
s 75% Sunflowers 25%.....	15.0%
s 50% Sunflowers 50%.....	7.3%
s 25% Sunflowers 75%.....	20.0%
flowers	20.8%

lthough the experimental silos were ghted with at least 200 lbs. of stone, it elt that the per cent dry matter of the crop n ensiled is a truer indication of the loss- ne might expect in larger silos where the ssure would be greater.

Representative samples were sent to the ision of Chemistry, Central Experimental m, Ottawa, where the analysis was made ler the direction of Dr. Shutt, Dominion mist.

The analyses are given in Tables 3 and 4. Dr. Shutt has discussed these silages brief- and I could not do better than quote Dr. utt verbatim at this point:

"Considering the five members of the ser- (as indicated in Table 3), it will be ob- ved that the percentage of dry matter de- ases with the increase in the proportion of flowers."

"All the samples in the series made up large- of sunflowers have a low dry matter con- ; No. 5 consisting of sunflowers only is spicuously poor, indicating marked im- urity when ensiled. The dry matter con- of this sample is 13.51 percent, whereas average from thirty-three samples of sun- ver silage analyzed by us in the years 1921- is 24.10 per cent".

Considering the protein content, the ser- compared *inter se*, weight for weight in fresh condition (as taken from the silo) w a marked falling off with the increase in proportion of sunflowers—which must, a very large measure mean a falling off in ritive value".

"As the proportion of sunflowers in the ge mixture increases the fibre content de- ases—due to the higher percentage of fibre the oats. The fibre in all silages contain- sunflowers is exceptionally low, due in, to the immaturity of the sunflower crop en cut. The fibre content of the oat silage,

TABLE 3.

Analysis of Silage from Oat and Sunflower Mixtures.

No.	Particulars	AS TAKEN FROM SILO							WATER FREE					
		Moisture	Protein	Fat	Carbo-hydrates	Fibre	Ash	Acidity	Protein Albuminoid	Protein Non-Albuminoid	Fat	Carbo-hydrates	Fibre	Ash
1.	Oats 100%..............	60.00	3.44	1.76	14.94	8.23	2.63	0.44	8.62	2.47	5.68	48.16	26.58	8.49
2.	Oats 75%; Sunflowers 25%.	80.07	2.71	1.23	8.67	5.33	1.99	0.97	10.60	3.02	6.13	43.48	26.79	9.98
3.	Oats 50%; Sunflowers 50%.	82.72	2.66	1.98	5.36	5.16	2.12	1.68	12.13	3.32	11.41	31.06	29.86	12.22
4.	Oats 25%; Sunflowers 75%.	84.31	2.37	0.75	6.53	4.18	1.86	0.62	12.80	2.32	4.78	41.63	26.69	11.78
5.	Sunflowers 100%........	86.49	2.27	0.64	5.13	3.47	2.00	0.49	13.37	3.49	4.69	38.00	25.66	14.79

TABLE 4.

Analysis of Corn, Sunflower and Oat Silages.

No.	Particulars	Moisture	Protein	Fat	Carbo-hydrates	Fibre	Ash	Acidity	Protein Albuminoid	Protein Non-Albuminoid	Fat	Carbo-hydrates	Fibre	Ash
6.	Corn	81.68	2.82	1.71	6.57	5.26	1.96	2.14	8.53	6.86	9.31	35.83	28.78	10.69
7.	Sunflowers	87.19	2.05	0.67	4.59	3.36	2.14	1.50	12.34	3.69	5.26	35.84	26.15	16.72
8.	Oats	66.34	4.12	2.79	16.57	7.83	2.35	2.36	5.87	6.38	8.29	49.27	23.24	6.92
9.	Sheaf Oat Silage.........	69.47	3.79	1.63	12.98	9.61	2.52	0.77	7.67	4.75	5.34	42.53	31.49	8.22
10.	Sheaf Sunflower Silage.....	86.84	1.87	0.59	5.08	3.64	1.98	0.33	10.42	3.80	4.42	38.55	27.71	15.10

FIGURE 2.
Oat, oat-sunflower and sunflower test rows as they appeared on August 31. Note that the sunflowers are making a more rapid growth than the oats at this period, also the relative height of the different crops.

though much higher than that of the sunflower, is low for this kind of silage, and is not regarded as excessive or as depressing the nutritive value of the other constituents".

"The analytical data of the "oat, oat-sunflower, sunflower" series are remarkably consistent, showing the regular gradation in dry matter, protein and fibre values following upon an increased proportion of sunflowers. They mark a steady decline in feeding value as the series proceeds from all oats to all sunflowers".

Dr. Shutt's analysis and summary agree with our own observations in that the silage produced from the oat-sunflower mixture is very superior to pure sunflower silage.

Observations during the progress of the experiment indicate additional points in connection with the oat sunflower mixture:

Growing oats and sunflowers in combination makes it possible to reduce the height and thickness of the sunflower stalk sufficiently to permit cutting the mixture with the ordinary grain binder.

The oats growing in the rows between the sunflower plants tend to choke out and prevent the development of weeds. It is better to grow oats with the sunflowers and improve the quality of the silage rather than weeds which tend to lower the quality of the silage.

Silage made from the oat-sunflower [illegible]ture does not freeze to the same exten[illegible] pure sunflower silage.

Combining oats and sunflowers elimin[illegible] drainage losses from the silo.

It is possible, where oats and sunf[illegible]ers are grown in combination, that the [illegible] might be permitted to become nearly ripe [illegible]fore cutting and the sunflowers still con[illegible] sufficient moisture to make a good silag[illegible] the mixture.

It is believed that the oat-sunflower mix[illegible] would make better stack silage than pure [illegible]flowers. The oats in the mixture would [illegible] the interspaces between the sunflower st[illegible] and thus tend to overcome excessive sett[illegible] of the stack and excessive decompositio[illegible] the surface.

Growing oats in rows as an intertilled [illegible] leaves the land in better condition than w[illegible] oats are grown in the usual way.

Conclusions

While one year's experimentation does [illegible] warrant conclusions being drawn, the w[illegible] feels that results indicate certain point[illegible] emphatically that tentative recommendat[illegible] are justified.

The writer believes that a 50-50 per [illegible] by weight oat-sunflower mixture seeded

drills so that the sunflower seed will be spaced approximately 8 inches apart in the row will produce a silage very superior in quality to pure sunflower silage; that the tonnage of dry matter per acre will exceed that produced by either corn or oats, and very little below pure sunflowers; that this mixture will be much easier handled than corn or sunflowers; and that the bundles from this mixture will make stacked silage to much better advantage than pure sunflowers.

The following points concerning the oat-sunflower mixture require farther investigation:

The admixture of oats and sunflowers seed which will give best results.

The rate of seeding the oat-sunflower mixture that will give best results.

The varieties of oats and sunflowers that will grow to best advantage in combination.

Silage Methods Tested

Four silos are used at the Experimental Station, Lacombe. They consist of two upright stave silos, a root cellar which is similar to a pit silo, and a trench silo. Corn, oat and sunflower silage has been kept in all of these silos. As a rule the sunflower silage is put in the pit and trench silos, while the corn and oats are cut into the upright silos. The reason for this is that the sunflower silage freezes to such an extent during the winter in the upright silos that it has to be chopped out, while it freezes very little in the trench and pit silos. On the other hand, oat and corn silages contain less moisture and appear to spoil more quickly than sunflower silage if large surfaces are exposed for considerable periods, as is the case where the trench silo is used. Oat silage does not freeze as much as either corn or sunflower silage.

That cheaper methods of silage production are needed is indicated by the present popularity of the trench silo. There are a large number of farmers, especially our new settlers and homesteaders, who have not the means to purchase ensilage machinery. With this in mind the Experimental Station, Lacombe, has started experiments to test the feasibility of making stack silage of oat and sunflower sheaves. Sections about eight feet long of both oats and sunflowers were built up in the trench silo. The sheaves had the butts and tops alternated to facilitate uniform settling. They were carefully placed and thoroughly tramped as the sections were built up.

The oat sheaves made silage most satisfactorily. They settled to about two-thirds their height. While the temperature during the fermentation process was very high, the loss through decomposition appeared to be only slightly more than would have been the case had the oat bundles been run through the ensilage cutter. The surface layer decomposed very quickly and sealed the silage heap, stopping further decomposition. The silage produced was dark brown in color and had a very strong pungent silage odour. Observations and analyses indicated that there is no reason why this method of making oat silage should not come into general use among farmers who are not in a financial position to purchase ensilage machinery.

The uncut sunflower sheaves did not make silage as satisfactorily as the oat sheaves. The pile settled to about one-third its original height, and the decomposition on the surface was much in excess of that developed on the oat sheaves. It was felt, however, that the latter point might have been corrected by covering the sunflowers with wet straw from an old stack bottom, or some similar material. The sunflower stalks and leaves were intact when removed and were not discoloured to the same extent that the oat sheaves were. This silage had every appearance of being an excellent cattle feed. It is doubtful, however, if the cattle will eat this silage as readily as that made from sunflowers which has been run through the cutting box.

I would like to repeat at this point that I believe the 50-50 oat sunflower mixture would make stack silage better than pure sunflowers. The oat stalks would take up the interspaces between the sunflower stalks, exclude the air, and thus eliminate excessive settling and decomposition.

FIGURE 3.
Stack Silage. Sunflowers being placed in the trench silo in the uncut condition for the production of stack silage. The use of the trench silo prevents decomposition at the sides of the stack.

The uncut oat and sunflower silages were analysed by Dr. Shutt. They are compared in the preceding tables, with other silages produced at the Station.

Dr. Shutt, in commenting on these silages states "The two samples of sunflower silage (Nos. 7 and 10) are evidently from an immature crop; they do not differ in any marked degree from No. 5, which has already been discussed."

"The two samples of oat silage, Nos. 8 and 9 call for no special comment; the results do not differ greatly from those of No. 1 which it has been pointed out is an oat silage of good quality in respect to dry matter, protein and fibre—decidedly superior to the samples of sunflower silage".

"The corn silage No. 6, is evidently from an immature crop, its dry matter content being at least five percent lower than the average for good corn silage. In respect to nutritive value it takes a place between the oat and sunflower silages as will be seen more particularly from the data for dry matter, protein and fibre. As compared with corn silage from a crop cut, say, in the firm dough stage, it must be considered as decidedly inferior."

It will be noted that Dr. Shutt does not differentiate between either sheaf oat and cut oat silage, sheaf sunflower and cut sunflower silage with respect to their feeding value as indicated by chemical analyses. While oat and sunflower silages which had been run through the cutting box would undoubtedly be eaten more readily than uncut silage, there appears to be no doubt that excellent silage can be provided for live stock by farmers who have no ensilage cutter machinery available.

The writer believes that the growing of the oat-sunflower mixture in rows as an intertilled crop and the use of the stack silage methods in ensiling this crop will be influential factors in extending the field for silage crops among the people of the west who need it most, and that the use of this crop in this way will be a decided step in advance in the solution of the silage question.

ACKNOWLEDGMENT

The author is especially indebted to Dr. F. T. Shutt, Dominion Chemist, Central Experimental Farm, Ottawa, for the analytical data and constructive criticism of the different silages which form an important part of this paper.

The Seasonal Water Requirements of Marquis Wheat.

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Losses due to Unseasonable Irrigation

During May, 1925, the Dominion and Provincial governments placed ten engineers in the irrigation districts of Southern Alberta to locate field laterals on at least 40 acres of each irrigated farm unit. In addition to surveying field ditches for the farmer, the engineers gave advice regarding the irrigation of the crop. The farmers were urged to build their field laterals in time to apply the first irrigation in June and to apply at least two additional irrigations during the growing season, one about the first week in July and the other about the first week in August.

In many instances the surveyed laterals were not built, nor the first irrigation applied, until after the crop had been damaged to such an extent by drouth that no amount of irrigation would enable it to produce a normal yield. This delay was due in some instances to a shortage of labour or equipment but on most of the farms that had suffered burnt crops, could be attributed to the farmers' ignorance of the seasonable water requirements of his crops.

Sufficient rain fell during the early part of the season to provide for the needs of the wheat crop. Instead of insuring an adequate supply of moisture by early irrigation, farmers placed too great a value on the rainfall already received and delayed irrigation, trusting that the early spring rains would continue and be ample for the crop. Some believed that "a good two-inch rain would carry the crops a month anyway", not knowing that the crop would require one inch of water every three to five days during the growing season. In every irrigation district fields could be found that would produce much less grain per acre than they were capable of producing because a sufficient amount of water had not been applied, but probably the greatest loss during the past season was due to unseasonable irrigations, or to the delayed application of the first irrigation.

Value of Data on Seasonal Water Requirements of Crops

In order to grow profitable yields per acre and at the same time prevent loss of fertility and rise of ground water by excessive percolation the irrigator must apply water (a) in irrigations of sufficient depth to bring the root zone occupied by the crop up to its optimum moisture content with the smallest amount of percolation loss, and (b) of sufficient frequency to provide the total amount of water required by the crop throughout its different stages of growth.

The data secured from irrigation investigations such as have been conducted at the Dominion Irrigation Experiment Station at Brooks, Alberta, will provide the water user with reliable information as to how much water crops require during each stage of growth and how much water different soils will retain within the feeding zone of the crop.

Experiments on Time of Irrigation

In experiments to define the time of irrigation, investigators usually follow the procedure of applying to the crops, either irrigations of different depths at definite stages of growth, or irrigations of definite depth at different stages of growth.

For example, an experiment was planned to determine the water requirements of grain by applying one irrigation at tillering and one at the boot stage and comparing the yield from this method of irrigation to that obtained by a method in which the first irrigation was applied when the grain was in the boot and the second while the grain was filling out. This method fails to give reliable data in that it does not determine the water requirement of grain during the different stages of growth. Its principle is supplying the crop

* Paper given before the Western Canadian Society of Agronomy, Saskatoon, Sask., December, 1925.

with a certain amount of water at different stages of growth and noting, in so far as is possible by the yield produced, the crop's reaction to the treatment. It is not conclusive or definite. A comparison of the value of a six-inch irrigation applied when the grain is in the boot, with the value of an irrigation of the same depth but applied when the grain was filling out would furnish no reliable information if the rainfall during the early stages of growth was insufficient to promote normal development. The crop irrigated during the boot stage would be in a much more vigorous condition at the heading out stage than the crop to be irrigated at that time, which may have suffered from drouth to such an extent as to be unable to utilize the irrigation fully when applied. If the irrigation during the early part of the season was sufficient to provide for normal growth and the precipitation during the latter part of the season was not, then the crop irrigated at the heading out stage would produce a better yield than that watered during the boot stage.

The following method, which was used at the Brooks Experiment Station from 1923 to 1925, has been found to give the most reliable and consistent results in the determination of the seasonal water requirements of crops. (1) That water content per foot in depth of soil which is most favourable to the development of the plant is determined by maintaining a number of plots at different moisture contents. (2) The amount of water used from day to day by the plants growing in soil maintained at the optimum moisture content is determined by frequent soil moisture tests.

Irrigations applied at one stage of growth and compared with irrigations applied at some other stage of growth to determine the time of irrigation, fail to produce reliable results because the plant usually has had such an unfavourable environment throughout some period of its growth as to cause a set-back which renders it incapable of making the most economic use of the water when applied.

The experiments described in the following text were planned and carried out along such lines as would eliminate the objectionable features of the comparison-of-irrigations method and yield reliable data on the seasonal use of water by wheat.

OUTLINE OF EXPERIMENT

Selection of Tract:

The tract of land to be used for this [e]xperiment must have a level surface to p[er]mit of the application of a uniform depth [of] water, and a soil and subsoil uniform in f[er]tility and texture and free from the influe[nce] of any ground or surface water other th[an] that received as irrigation or rainfall.

Size and Treatment of Plots:

The area selected as most nearly fulfilli[ng] the above requirements was divided into fi[ve] plots, designated as 32A, 32B, 32C, 32D a[nd] 32E. The water content of 32A to a depth [of] four feet was maintained from seeding to h[ar]vest at the proportion of one inch in dep[th] of water per foot in depth of soil, or o[ne] acre-inch of water to one acre-foot of soil, [a] content known to be too low to permit of no[r]mal growth. Plot 32B was maintained [at] 1.25 inches of water per foot in depth of soi[l]; plot 32C at 1.50 inches; plot 32D at 1.[75] inches, and plot 32E as near 2.00 inches [as] possible. The optimum content would be i[n]dicated by a comparison of the yields fro[m] the five plots.

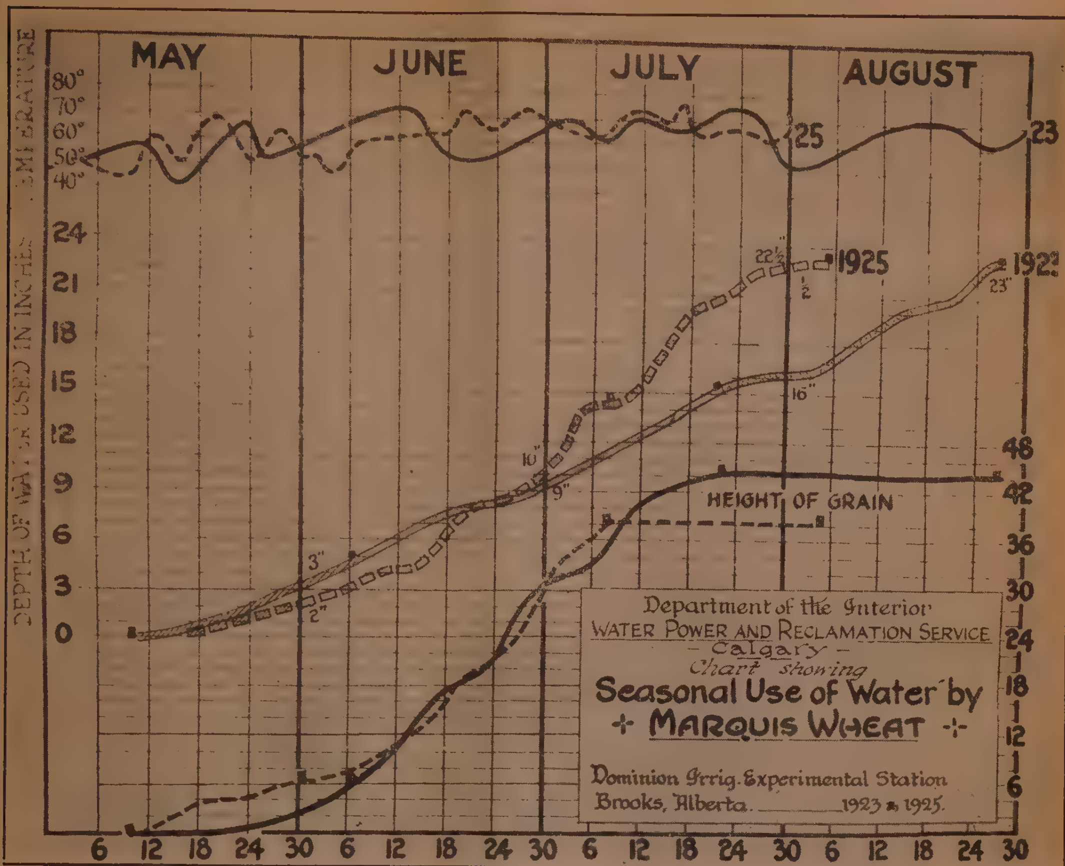
Each plot was 20 feet in length, 10 fe[et] in width and 0.00459 acre in area. The pl[ot] surface was levelled before seeding, by mea[ns] of a 12-foot straightedge reaching across t[he] plot and sliding on two 2 x 4's that had be[en] embedded and levelled, one on each side [of] the plot flush with the ground surface.

Seeding:

On April 29th, Marquis wheat was so[wn] 1½ inches deep and at the rate of two bu[sh]els per acre by means of a press drill.

Borders:

Before irrigating, each plot was surroun[d]ed with a border of 1″x12″ boards, set [on] edge and embedded for one-half their wid[th] in the ground. These boards were backed [on] the outside of the plot with earth and serv[ed] to retain the irrigation water on the plot. [No] earth backing was placed on the side of t[he] boards nearest the plot, thus making possib[le] irrigations having the same depth and pen[e]tration at the extreme edges of the plot [as] in the centre.



Isolation Trench:

A trench, six feet in depth and two feet in width, was made around each plot. The trench wall nearest the plot was on the same vertical plane as the plot border-boards. This wall, to a depth of from 5 to 6 feet was covered with first a layer of canvas and then with a layer of tar-paper. After these coverings were in place the trench was filled with the excavated earth, well moistened and tamped. This impervious wall, extending unbroken around each plot, served not only to retain within the plot to a depth of 5 or 6 feet all irrigation and rainfall received, but also to keep out any moving ground-water resulting from rains, surface waste or seepage.

Determination of Moisture Content:

The moisture content of each plot to a depth of four feet was determined at the time of seeding and twice each week following until harvest. Every third test the soil was sampled to a depth of six feet. All samples were taken from an area three feet wide and ten feet long, extending across the plot's smallest dimension. Each sample taken should represent, as accurately as possible the moisture content of the plot as a whole; therefore the condition of the soil, subsoil, mulch, and stand of grain where the sample is taken, must be the same as that of the remainder of the plot. To maintain this condition it was necessary (1) to take the samples from a portable, table-like platform, three feet in height with four wide-bottomed support-legs which could be placed over the point to be sampled without any damage or disturbance to the stand of grain or soil surface; (2) to refill the hole made by the soil sampling tube with tamped earth of as near the moisture content of the extracted sample as possible, in order that the moisture content of the subsoil would not be affected by the entrance of irrigation water or air which would occur if the hole were left open; and,

(3) to take each sample at a distance of not more than two feet from the location of the immediately preceding sample in order that any change in the volume, weight, or texture of the soil between sample-holes would be gradual.

VOLUME WEIGHT:

The volume weight per cubic foot of the fine sandy loam soil of plot series 32, as determined from samples taken from the trench walls, is given in the following table:

1st foot	68 lbs.
2nd "	76 "
3rd "	78 "
4th "	78 "
5th "	71 "
6th "	83 "

WEIGHING AND BAKING SAMPLES:

The soil samples are weighed immediately after being collected, then baked until all moisture has been drawn off, and again weighed. This gives the moisture content of the sample in per cent of the dry weight of the sample. The moisture content of each foot of soil in inches depth of water per foot in depth of soil, is obtained by the following formula in which D=inches in depth of water, W=dry weight of a cubic-foot of soil, and P=the moisture content of the sample in per cent of its dry weight. The weight of one inch of water over one square-foot of soil=5.2 pounds.

$\frac{D = W \times P}{5.2}$, or for a sample of soil containing 20 per cent moisture and having a volume weight of 78 pounds per cubic foot, $\frac{D = 78 \times 20}{5.2} = 3.0$ inches of water.

WATER USED IN GROWING THE CROP:

The total amount of water contained in the soil to a depth of four feet, as determined by the soil moisture tests, is plotted on a graph. The amount of water used in growing the crop during any period is determined by adding to the moisture content of the soil at the beginning of the period, the amount of moisture received during the period as precipitation and irrigation, and from this sum deducting the amount of moisture remaining in the soil at the end of the period. The term "water used in growing the crop" does not refer solely to the amount of water transpired by the plant but represents the amount of water extracted from the root feeding zone by transpiration through the plant evaporation from the soil surface, and percolation below the root zone. Every water user will have and must consider these three ways through which water supplied to his soil is extracted or lost. This use of water is influenced by the area of the leaf surface of the plant; by climatic conditions such as sunshine, temperature, humidity, and wind; by the extent of root development; by the amount of water in the soil; by the depth applied in irrigation; and by the fertility, texture and structure of the soil.

MEASUREMENT AND APPLICATION OF WATER:

Water was applied to a plot by irrigation whenever the total amount of water in the four-foot soil column as shown by the bi-weekly moisture tests, had dropped below the standard maintained for that plot sufficient to require a two-inch irrigation to bring the content back to normal.

The water applied to the plots was measured through a 60 degree "V" notch weir and conveyed to the inner edge of the plot border boards in wooden flumes. In the irrigation of a plot it was necessary that the head of water delivered to the plot be sufficiently large to cover the entire plot to a uniform depth almost immediately upon being turned into the plot, otherwise that part of the plot adjacent to the point of delivery would be covered with water for a greater length of time and consequently absorb more water during the irrigation period than parts of the plot farther away. This method of irrigation required simple, easily manipulated gates and accurate stop-watch timing.

OPTIMUM WATER CONTENT:

The optimum water content for the production of wheat on the fine sandy loam soil of plot series 32 in 1925 was found to be 1.5 inches per foot. A similar experiment conducted in 1923 on a silt loam soil of much higher water holding capacity than that of series 32 gave the maximum yield per acre from the plot (41B) maintained at 2½ inches per foot, or 40% of pore space filled with water.

TABLE No. 1

Yield Produced with Different Maintained Contents

Plot No.	Moisture content maintained throughout the season at	Total depth of water used in Growing crop.	Percent of total Pore space of soil occupied with water.	Yield of Wheat in Bushels per acre.
32A	1.00 inch per foot depth	9.0 inches	17	12.5
32B	1.25 " " " "	13.6 "	22	28.0
32C	1.50 " " " "	23.0 "	26	39.7
32D	1.75 " " " "	31.3 "	31	38.5
32E	2.00 " " " "	33.5 "	35	32.9

Plot 32C, yielding maximum for the series of 39.7 bushels per acre, indicated the optimum maintained moisture content for this crop and soil to be 1.50 inches per foot. The crop was cut August 4th.

The fine sandy loam soil of the 1925 experiment has a maximum capillary capacity of from 2.0 to 2.5 inches. The silt loam soil of the 1923 experiment has a maximum capacity of 4.8 inches, twice as much as the fine sandy loam.

The chart on page 245 shows the amount of water used in producing a yield of 5.0 bushels per acre of Marquis wheat in 1923 on plot 41B, and a yield of 39.7 bushels per acre in 1925 on plot 32C. The 1923 crop was grown on land that had been in alfalfa the previous year; that of 1925 was produced on land that had been cropped to peas in 1923 and wheat in 1924. The moisture content of plot 41B, which was on a silt loam soil, was maintained at 2½ inches per foot; that of plot 32C, which was on a fine sandy loam soil, was maintained at 1.50 inches per foot. Plots maintained at a greater or lesser water content than 41B in 1923 or 32C in 1923 did not produce as much grain per acre.

In 1923 Plot 41B used 23 inches of water between seeding and harvest; 3 inches in May, 6 inches in June, 7 inches in July and 7 inches for the first 22 days in August.

In 1925, Plot 32C used 23 inches of water between seeding and harvest; 2 inches in May, 8 inches in June, 12½ inches in July and ½ inch during the first four days in August.

The graphs of daily soil moisture content showed that neither of these two plots lost any appreciable amount of water by percolation below reach of the roots. The transpiration loss, which for these plots was the largest and most important of the three losses,—transpiration, evaporation, percolation,—was influenced principally by the mean daily temperatures and by the area of leaf surface of the plant. The diagram shows an average curve of the mean daily temperatures for each of the two seasons, plotted above the water use curve; and the height of grain, which is indicative of the leaf surface of the plant, plotted below the water use curves for each year.

The amount of water used daily varied from one inch every 7 to 10 days in May to one inch every 2½ or 3 days in July and August.

While the plants were small the larger proportion of the water was lost by evaporation. As the plants increased in height and leaf surface and provided more shade, the evaporation loss decreased and the transpiration loss increased.

For 1923, the transpiration loss increased with the growth of the plant until July 22nd when the plant had reached its maximum height and leaf surface. For 1925, the grain attained its maximum height on the 4th of July, 18 days earlier than in 1923.

The mean daily temperature, the other important factor influencing transpiration, shows a general increase from the first of May until the latter part of July. These two influences on transpiration, increasing each month, produce an increase in the rate of the use of water by the plant. The rate of use increased from one inch every 7 to 10 days in May to one inch every 2 to 4 days in July and early August.

The effect of temperature and humidity on the use of water is shown by the flattening out of the use curve during cold rainy weather and by the rapid increase in steepness of the curve during the periods of hot, dry weather. During the first four days of July, 1925, (clear

TABLE NO. 2

Showing amount of water during three different stages of growth.

	1923 Total Depth Used (In.)	1923 No. of Days in Period	1923 Av. depth Used per Day (Inches)	1923 Mean temp.	1923 Precipitation (Inches)	1925 Total Depth Used (In.)	1925 No. of Days in Period	1925 Av. depth Used per Day (In.)	1925 Mean temp.	1925 Precipitation (Inches)
From date of seeding to a height of six inches......	4½	32	.14	55.3°	0.98	3	32	.10	54.0°	0.46
Between 6″ height and the end of growth in height......	10½	45	.23	64.3°	5.08	11	33	.33	61.4°	2.62
Between end of growth in height and harvest........	8	31	.26	64.6°	2.64	9	30	.30	66.7°	1.65
	23	108			8.70	23	95			4.73

and hot) plot 32C lost water at the rate of ¾ inch per day. During the next four days (cloudy and rain) it lost water at the rate of only ⅛ inch per day.

The crop growing on these plots has been maintained throughout its growing season at the optimum soil moisture content, therefore the water used throughout any period of its growth is indicative of the water requirements of wheat growing under similar conditions through these different periods. That is, instead of applying irrigation when the crop is tillering, or in the boot, or heading out, for the purpose of determining the time of irrigation, one is able to determine exactly what the crop will require during any or all of these three stages of growth by the information furnished by this or a similar experiment.

Table No. 2 gives the amount of water used by wheat during its three different stages of growth.

When compared by months the 1925 crop used 20½ inches of water during the months of June and July, the 1923 crop only 13 inches. But when compared by stages of growth it will be noted that for each crop the amount used is nearly the same.

During the first period of growth the 1923 crop used water at the rate of .14 inch per day; mean temperature 55.3°; the 1925 crop used only .10 inch per day because of lower mean temperature, 54.0°.

During the last two periods of growth the 1923 crop used water at an average rate of .245 inch per day, the 1925 crop .315 inch per day. The more rapid daily use of water by the 1925 crop during the last two periods may be attributed to a lighter and warmer soil, more favourable weather during the period of maximum leaf surface, and a slightly greater percolation loss due to the lower capillary water holding capacity of the lighter soil.

During July 1925 the application of 18 inches of water was required to maintain the light soil of plot 32C at a moisture content of 1.5 inches per foot in depth; during the same month in 1923 only 10 inches of water was required to maintain the heavier soil of plot 41B at 2½ inches per foot. 41B, a soil of fine texture, was holding water to not more than one-half of its capillary capacity while 32C, a soil of much coarser texture, was holding up to three-fourths of its capacity.

When the soil of plot 32C contained 1.5 hes of water, thirty per cent of the pore ice of the soil was occupied by the water 1 70 per cent with air. When the soil of B contained 2.5 inches of water, 40 per cent the pore space was occupied by water and per cent by air. The soil of plot 32C conned a higher percentage of air and theree warmed up quicker and to a higher temrature than the soil of plot 41B. This inased the daily use of water in that not only s there a higher rate of evaporation from surface soil, but also a greater percolation s due to the reduction of the surface tenn of the capillary moisture film and a conuent decrease of the capillary capacity of soil. This loss is especially noticeable en the amount of water used by the two ls during the month of July is compared. The wheat growing on light sandy loam l (1925) used more water during June d July than that growing on the silt loam l (1923) because: 1, it reached its maximum height 14 days earlier and had 22 days of full leaf surface draft as compared with eight days for the 1923 crop; 2, it had more favourable temperature and rainfall; 3, it had a greater percolation loss due to lower water holding capacity of soil and higher percentage of air space in soil.

The data obtained from these two experiments show that the water requirements of a crop of wheat is almost uniform throughout the season after tillering, averaging between 1/4 and 1/3 inch of water per day.

A series of experiments along this line will determine the amount of water the irrigator must supply to his crops during their different stages of growth to obtain the maximum yields. By having this information and knowing the water-holding capacity of the root zone occupied by any specific crop, he can apply irrigations of the correct depth at such times as will provide for the needs of the crop through any stage of growth.

Landmarks in Early Maritime Agriculture.*

R. P. GORHAM

Dominion Entomological Laboratory, Annapolis Royal, N.S.

Landmarks are numerous, varied, and may ve many forms. Some may be actual rks as stones, trees, posts, some historic as ttles, acts of legislation, some industrial great inventions like the electric light and ving machine, social as free schools, the covery of insulin, etc. In one sense they akin in marking a beginning of some d, a particular place, time or act. The nts of one day are the hstory of the next, nearly all landmarks are historic in some y. Accordingly in writing of the first steps the establishment of agriculture, in the ritime Provinces, the title of "Landrks" may be used in a broad sense to er a number of different things which re the first of their kind in our country d which stand out in the written history things worth remembering.

With the exception of the Norsemen's reds of visits to Markland and Vineland which are more than a thousand years old and somewhat indefinite, the story of agriculture in the Maritime Provinces of Canada may be said to have had its beginning on the last day of June in 1534. Regarding that date the narrative of Captain Jacques Cartier reads: "We went that day on shore in four places to see the trees which are marvellously beautiful and sweet smelling; we found them to be cedars, yews, pines, white elms, ash trees, willows and many others to us unknown, but all without fruit. The grounds where no woods are, are very fair and all full of peas, white and red gooseberries, strawberries, black raspberries and wild wheat, like rye, which seemed to have been sown there and cultivated. This land is of the best climate that can possible be and very hot. There are there many pigeons

* Read before Section 2 of the Royal Society of Canada, May, 1925, by Laurence J. Burpee.

and ring-doves and other birds, there wants nothing but good harbours."

These landings are supposed to have been on the north coast of what is now Prince Edward Island, and in speaking of the grounds "where no woods are" and "where a wild wheat, like rye, appeared to be cultivated" it seems possible that he had found an Indian cornfield with the young plants just beginning to show the spikes of staminate flowers. The peas may have been vetch or the beach pea found along Atlantic shores. The trees were without fruit for it was early in the season but the berries of the fields were beginning to ripen and were, no doubt, welcome to the eye and tongue of men who had been two months and ten days on the sea. The description is at least that of a goodly land and an auspicious beginning for the agricultural record of our country.

The next two landmarks have to do with the introduction of the domesticated animals of Europe to the northern port of America. To the Portuguese has been ascribed the placing of horned cattle on the sand wastes of Sable Island but just when is somewhat in doubt. The first French expedition having the design of establishing a colony in Acadia started under the Marquis de la Roche in 1598. It ended on Sable Island where some forty men were landed and struggled for life as best they could for five or more years.

> "For food, the castaways had only fish, supplanted for a time by a few stray cattle found on the island, for clothing the skins of seals, for shelter some weather beaten timbers from early wrecks. With wild eyes and with unkept hair and beards they looked as an old chronicler vividly says, like river gods of yore."

Less than a dozen men survived the experience of this attempt to colonize Acadia, but they were the first, of whom we have information, to use European animals for food in America.

When Champlain and the Sieur de Monts started from Havre in March of 1604 to attempt the colonization of Acadia they had with them a supply of field and garden seeds of various kinds and some animals. Of the latter we find but slight mention. On the south shore of what is now Nova Scotia they entered two harbours to which Champla gave names; one of them, on account of t fact that a sheep leaped overboard from t vessel, was called Port Mouton, a name whi it bears today, a lasting monument to the rival of the first sheep in Acadian territo and it may be of the beginning of the she industry in Canada. Early references to fa animals are rare and it is not clear wheth or not the early colonists reared sheep the records show they did pigs. Not un the census of sixty-six years later do we fi the name of an individual breeder. In th year Jacques Bourgeois was listed as havi at Port Royal thirty-three horned anima "un petit troupeau de moutons et cinq a ents de blé."

Near the end of June, Champlain and Monts reached the river which they nam the St. Croix and on one of the islands that river they determined to spend the w ter. Houses were erected, land broken a gardens planted on this island. The soil w sandy and fresh water scarce so that t plants did not thrive well. Other garde were made on the mainland, on the easte side in what is now New Brunswick and the western side of the river in what is n the State of Maine. These are clearly sho on Champlain's map of the island and s roundings and in connection with the garde on the east bank is the drawing of a cab while on the west bank is shown the pla where preparations were made for the er tion of a water mill.

Thus it appears that the honor of the fi white man's gardens in the Acadian coun is divided between Maine and New Brunswi

Still other gardens were begun at the fa of the St. Croix at the site of the present Stephen. Regarding these Champlain's n rative reads, in the English translation Otis:

> "Two leagues up this river is a water f where the Indians carry their canoes o land some 500 paces."

> "Vessels cannot pass this fall because th is nothing there but rocks and only four five feet of water. In May and June th is taken there so great an abundance of h ring and bass that vessels could be loac with them. The land there is of the b and there are fifteen or twenty acres clea

where the Sieur de Monts had wheat sown which flourished well."

In chapter *six* of the narrative Champlain again noted these fields.

> "Sieur de Monts caused also clearings to be made on the mainland for making gardens and at the falls three leagues from our settlement he had work done and some wheat sown which came up very well and ripened."

In these references we note the beginning of wheat growing in the northern part of America in the year 1604. It seems possible that the area at the falls of the St. Croix was originally an Indian cornfield and that De Monts utilized a part of it to plant wheat. Champlain and Poutrincourt visited the fields in 1605 and Marc Lescarbot mentions that in 1606 ripened grain was found there from self-sown seed of the previous year. There is nothing definite to indicate on which side of the falls the wheat fields were so it is a matter of doubt whether to St. Stephen or Calais belongs the honor of the site of the first wheat field of Acadia and incidentally of the northern part of North America.

In the spring of 1605, the colony moved to Port Royal and erected new habitations on the north side of the basin. Gardens were made that year but of these Champlain's narrative has little to say.

"As soon as Sieur de Monts had departed (for France) a portion of the forty or forty-five who remained began to make gardens. I made one myself to escape ennuie, it was surrounded with ditches full of water in which there were some fine trout which I had captured and into which there emptied three streams of very fine running water."

"I sowed there some seeds which prospered well and I had great enjoyment there, but much work had first to be done."

In July 1606, Sieur de Poutrincourt returned to Port Royal from France bringing with him Marc Lescarbot, his friend and able assistant in the future work of the colony and its first historian. Continuing Champlain's narrative we read that the day following his arrival Sieur de Poutrincourt proceeded to discuss what the future of the colony should be:

> "And with the advice of all determined to stay at Port Royal for this year."

> "On this decision the Sieur de Poutrincourt at once sent some laborers to work on the land at a place he thought fitting, within the river a league and a half from the settlement of Port Royal where we had thought of making our residence, and had wheat, rye, hemp, and several other seeds sown there to see if they would flourish."

Later Champlain and de Monts went on an exploring trip along the coast of what is now New England and to Marc Lescarbot was confided the care of the gardens. In this Lescarbot took great pleasure and notes in his History of Nouvelle France:

> "Car je puis dire sans mentir que jamais je n'ay tant travaille du corps, pour le plaisir que je prenois a dresser et cultiver mes jardins, les fermer contre la gourmandise des pourceaux, y faire des parterres, aligner les allees, batir des cabinets, semer fromant, segle, orge, avoine, fever, pois, herbes de jardin, et les arrouser, tant j'avoy desir de reconoitre la terre par ma propre experience. Si bien que les jours d'este m'estoient trop courts, et bien souvent au printemps j'estois encore a la lune."

In addition to the grains wheat, barley, rye and oats and the cordage plant hemp, we find that Lescarbot mentions in his history peas, cabbage, radish, rope and flax so that by 1606 we see the beginnings of vegetable gardening at Port Royal and also the culture of plants for cloth.

Moreover, we note the erecting of fences to prevent the hogs destroying the garden and the making of cabins or pens for the hogs, two things which have ever since been associated with swine breeding and with horticulture, the culture of enclosed fields. Cartier had planted turnip seed at Mount Diamond seventy years before Champlain came to Acadia but during the intervening years no other plantings had been made of which we find record. In Acadia the culture of vegetables has been carried on continually since 1605.

Acadia was a densely forested land and in the forest were bears as there are today, which are fond of the smaller farm animals including pigs. Bears are said to dislike crossing water and hunters state that moose take their calves to islands in the streams

and lakes to protect them from attack. What more natural then than that the first colonists should put their pigs on an island to keep them from straying in the forest and falling a prey to bears? That the colonists at Port Royal did this is indicated in the grant by the Chevalier D'Aulnay, prior to 1650, of an Island near Port Royal which is called in the record Isle aux Cochons or Isle of Pigs. Shortened to Hog Island it bears the name to this day, a name commerative of the beginning of swine rearing in Acadia. Its counterpart is found in the St. John River in New Brunswick where an island which was close to the residence of the Sieur de Belleisle was called Isle aux Cochon in the French Period and is Hog Island today.

With the ripening of grain, fenced enclosures, pigs in cabins and vegetables growing for the table and cellar, agriculture had made a good start at Port Royal in 1606. As has been mentioned, De Monts had begun preparations for the construction of a mill at St. Croix in 1604 but it was not completed. To Lescarbot is commonly credited the beginning of the water mill at Port Royal. The Sieur de Pourtrincourt and Champlain were absent for a large part of the summer of 1606. On their return Champlain notes that he began to prepare a garden for the next spring and

> "That the Sieur de Poutrincourt for his part had a water mill built almost a league and a half from our dwelling, near the point where the wheat had been planted."

This point was later the site of the fort of Port Royal and of the present town of Annapolis Royal. The mill which Lescarbot says was much admired by the Indians was the first erected in North America and it began to grind wheat thirteen years before the Mayflower landed its load of Pilgrims at Plymouth. The remains of the dam of this mill may still be seen at the head of the tide on the little stream now called L'Equille. Of the many who visit Annapolis Royal each year, but few know anything of it, an interesting relic of the first mechanical industry in North America.

The practice of agriculture makes roads a necessity in any region, Champlain notes the construction of the first Canadian road in the winter of 1606-7 which he began and constructed for 2000 paces and the Sieur de Poutrincourt continued for a half league towards the entrance of Port Royal.

In that same winter the preparation of charcoal for the smith's forge and the making of brick for a furnace may be classed among agricultural and industrial acts. Two others may also be mentioned as the first of their kind by the white man in Canada: the extraction of Canada balsam from the bark of the fir and the curing of sardines for export. Still more important from a social aspect may be mentioned the organization of the first social club and the production of the first play, while from a botanical standpoint we find the record of the first study of the plants of the new world by Louis Hebert, the apothecary, called by the Micmacs according to Lescarbot, "ce bon ramasseur d'herbes".

It was unfortunate that after making such a splendid beginning in agriculture Poutrincourt had to leave Port Royal in 1607, but this had its recompense in the better equipment he brought on his return in 1610 with farm animals for labor and iron plows to break up the soil of Acadia. In that year also, we read of the first purchase of a purely agricultural commodity when a vessel was sent from Port Royal to the north of the Bay of Fundy to obtain by barter a load of corn from the Armouchiguois, "ce peuple passait pour cultiver une grande quantitie de mais".

At a later date we find mention of a farm at Round Hill, a short distance east of Port Royal, where colts, calves and pigs were reared, the first mention of the breeding of these animals in Acadia. When Argall undertook the destruction of the colony in 1613 we find mention that taking advantage of the tide he sent a force up the river to where the farm animals were grazing on the prairie at two leagues distant, where they took some horses and colts and a goodly number of pigs, but fearing to be stranded in the stream by the receding tide they did not complete the destruction of the farm crops.

The feudal tenure of farm lands appears on the records of the settlement of Isaac de Razilly in 1632 at the port of La Have where the immigrants brought out in his four vessels were landed and grants of lands made to each family "sous les conditions de cen-

ve ordinaire". The exact conditions of ese grants do not appear but Rameau in s "Colonie Feodale" states that seigniorial visions of land in other parts of Canada at later date were usually in lots of one-indred arpents at a rental of one or two ls per arpent plus a half bushel of wheat r the entire lot. In addition there were mmonly some regulations regarding the inding of grain only at the mill to be erect- by the seigneur.

De Razilly worked to organize his colony. arm animals were distributed among the milies, land was cleared and broken and Rameau words it:

"Au bout de quelques mois il eut la satisfaction de voir le porten de bois que lui servait de magasin et de ranor, entoure d'un certain nombre de petites fermes ou demeuraient ses vasseaux qui commencerent des lors a defricher et a ensemencer le sol; les femmes et les enfants reprenacent en meme temps le cours interrompu des occupations menageres et domistiques qui etaient a leur usage dans leur patrie primitive."

In the same year that the La Have colony as established, Charles La Tour made ef-rts to attract settlers to the St. John River gion and on the 6th of March 1632 had iblished in Rochelle the first advertisement which we have record of New Brunswick nds as open for immigrants. These were Jemseg and are described as lands of great rtility and abounding in all sorts of birds id game animals, a description which af-r the lapse of three centuries is still good, r at Jemseg are some of the most fertile eadows and farms of the province, also one the best duck shooting regions and a place here moose gather in numbers in the sum-er months and feed unmolested along the reams and watercourses. The writer has rsonally seen a half dozen moose during afternoon paddle there and heard from sidents of as many as twenty being seen gether on the marshes and all within two iles of a village and railway.

When Sieur d'Aulnay took charge of af-irs at Port Royal one of his early improve-ents was the installation of a saw-mill in nnection with the earlier grist mill of Pou-incourt on the stream now called L'Equille. record exists of planks sawed at this mill being taken to the St. John River for the use of the inhabitants settling there so there is no doubt it was in operation earlier than any mill in that region. D'Aulney had had constructed also the first windmill of which we find mention for grinding grain.

The mill and its operator were important in the establishment of new settlements and in connection with the early settlement of the Petitcodiac River one Pierre Thibaudeau, miller of Round Hill, took a leading part. With his sons he made a clearing at the junction of the Petitcodiac and Memramcook rivers in 1698 and "with two oxen, a horse, utensils and flour for six months" began the settlement of that region. At the close of the summer all returned to Port Royal for the winter leaving to the care of the friendly Indians the improvements made the first year. Opposition to his establishment developed at Port Royal and although his sons continued the improvements to some extent the following year, it was not until 1700 that with a grist mill and saw-mill outfit obtained from Boston, Thibaudeau having the grant of a seigneurie, really established himself on the river with "Toutes les munitions necessaires, et une basse cour complete, un cheval, des vaches, un taureau, des porcs, de la volaille etc".

The good lands of the Petitcodiac enhanced in value by the presence of a saw-mill to furnish lumber for building and a grist mill to supply flour attracted other settlers and the census of 1702 shows 48 inhabitants, three half breeds hired to help, three horses, 47 horned animals, 24 sheep and 64 pigs, in the colony. In connection with a fete in honor of M. Thibaudeau that year, we find the first mention of the use of a wagon in what is now New Brunswick.

When Champlain sailed for the St. Lawrence in 1608 to establish a new colony he took with him by direction of Sieur de Monts apple shoots to plant in the new land. Two years later Sieur de Poutrincourt left France on his return to Port Royal. He was one who had the agricultural interests of the place at heart and took with him horses, cattle, plows and various seeds. It appears possible that he also had apple trees although there is no mention of them until years later when they would perhaps be fruiting. Lescarbot mentions that Poutrincourt's son plant-

ed seeds of the orange and lemon which grew shoots a foot high in the space of three months. These, of course, did not survive the first winter but it is of interest to note that they had an earlier record in Port Royal than the apple.

The first definite record of apple trees appears in the census of 1633 where they are mentioned on various farms beside the Rivers Dauphin and L'Equille at Port Royal and the Canard and Gaspereaux on Minas Basin. The year before this census D'Aulnay de Charnisay and Nicholas Denys had arrived in Acadia and Le Tour had advertised for colonists for his lands at Jemseg. All three of these men took more or less interest in spreading the culture of fruit trees in after years. D'Aulnay's governorship was confined to Port Royal and the region along the Bay of Fundy where the growing of apples spread rapidly. Denys records in his narrative that at his establishment at Nipisiquit (close to the present town of Bathurst, N.B.) apples, plums and pears grew better than at any other of his posts.

The report of Sieur de Grandfontaine on the conditions of Fort Jemseg in 1671 enumerates in detail the features in and about the fort including the fenced garden of apple and pear trees which must have been planted by some of La Tour's colonists and was probably the first orchard on the St. John River.

To an Irishman, Roger Quessy, who had been taken prisoner by and had later settled with the French at Port Royal is given the credit of planting the first fruit trees at Beaubassin, at the head of the Bay of Fundy. Having married at Port Royal he went with others to establish a colony there and in the census of 1686 is listed as having eight arpents of land in cultivation, 18 horned animals and 6 sheep. In the census of 1696, in addition to his farm-stock mention is made that he had thirty fruit trees, the only ones at that settlement.

Education for Indian youths in the Christian faith and in European methods of agriculture were the objectives of the Seminary established by D'Aulnay de Charnisay at L'-Equille in 1634 and for the carrying on of the latter a grant of land was given to the school. It was under the direction of monks of the Recollet faith and of its brief existence the records are fragmentary. In t next school of which there is record at Po Royal a woman teacher officiated, the fi in Acadia.

Flax was grown in what is now New Brun wick and linen cloth made from its fibre early as 1635. In that year the Intendant Canada, M. de Meulles, visited the settlemen at the mouth of the Petitcodiac and has l an interesting record of the people who we "very happy and little dependant on stran ers". He mentions that they made all the own cloth for clothing, wool and line stockings and moccasins and had an abun ance of live stock. The mention of loss of animals by attacks of wolves on wh are now known as the Tantramar Marsh is found in this report. Frequent mention flax is found in later records of the Fren period and it was seemingly widely grov around the Bay of Fundy. In the early En lish period it has scant notice until the ye 1766 when the then Lieutenant-Governor Nova Scotia reported that the Irish coloni of Truro, Onslow and Londonderry, had pr duced that year 7524 pounds of flax a made all their own linen and some for sale other townships.

Bounties for the production of agric tural crops were offered by the Council Nova Scotia in 1752, 20 shillings an ac for land cleared and broken, two shillin a hundredweight for hay, two shillings bushel for wheat, barley and rye, one shilli a bushel for oats and three pence a pou for hemp. Food was sometimes scarce Halifax in early days and in Murdock's h tory we find at a latter date a letter from t Governor of the province to the commandi officer of the troops, the Duke of Kent, commending as a food conservation measu that private soldiers and non-commission officers should refrain from using hair po der.

Halifax had a tree preservation law at early date, imprisonment for 48 hours and fine of £5 being provided for anyone cutti or hacking trees within the barricades, "Th trees to be kept as ornaments and a prot tion for the town." In the same year as t tree protection act, 1749, a bounty of guineas was offered for "each Indian livi or dead or his scalp as is the custom America."

Note was made by Lescarbot of the white alnuts or butternuts on the St. John River, ıt no attempt seems to have been made to ıltivate nut trees before the English occupaon. Major Winniet of Annapolis Royal eems to have been the pioneer in this with ome success. A letter of General Ruggles, ated July 1783, mentions that Major Winiet had a Shagbark hickory tree of 23 years rowth and as large as a man's body, also filbert bearing an abundant crop, while the next garden was a maderia nut tree. eneral Ruggles soon after introduced the lack walnut to his place near Wilmot.

Insects as pests of farm crops were menoned as early as 1751 on Isle St. John, now rince Edward Island. In that year settlers ere reported in a starving condition at one ettlement due to the loss of their grain by ocusts.

Soon after the Loyalist settlement in New runswick and Nova Scotia, the Hessian Fly ecame noticeable and an embargo on the imortation of wheat was considered. In a leter from Ward Chipman of St. John to Edard Winslow, written in 1789, we find the ame of an early entomologist.

> "With respect to the Hessian Fly there is a Capt. Clements just come from New York who I understand has taken pains to inform himself respecting its operation. He says it does not touch the grain nor is communicated by it.
> But as to the prohibition of wheat on that account I have always thought it wise that no risk should be run."

The insect gained a foothold in New Brunswick it would appear, for the official report to the government on the state of agriculture in 1803 in Kings County states in part,

> "This county is principally agricultural and annually sends about 200 or 300 barrels of flour to market, formerly more but the ravages of the Hessian Fly have considerably reduced the exportation."

In Nova Scotia the insect was also injurious and is mentioned in a letter from the Lieutenant Governor to the Duke of Kent as responsible for a serious shortage of grain. It was on account of this shortage of grain that the curtailment of the use of hair powder by private soldiers and non-commissioned officers was recommended.

There are other interesting things which might well be classed as landmarks but this article is already long and will be closed with a note on weed control.

In 1822, the court of General Sessions of Yarmouth County, N.S., ordered for the township of Argyle,

> "That for every thistle that shall be allowed to ripen the seed the owner of the land whereon such thistle shall grow shall pay a fine of six pence for one thistle, for two thistles a shilling, and six pence for each additional thistle until the sum amounts to twenty shillings and no more. This to include the middle of the highway fronting said land."

LIST OF C.S.T.A. MEMBERS

Each member of the Society should receive copy of the List of Members at about the ıme time as this issue of the magazine. Pubcation of the list has been delayed by numrous changes of address and it was necessary ensure as much accuracy as possible before oing to press. The List of Members is a 4-page pocket booklet and contains the ames and addresses of 928 members. If our copy does not reach you by March 15th, lease notify the General Secretary.

C.S.T.A. ELECTIONS

Members are reminded that nominations for the Dominion officers of the Society, to hold office during the year 1926-27, must be in the hands of the General Secretary by March 31st, 1926. From these nominations an election ballot is prepared and mailed to each member of the Society on April 10th.

The nominations must be endorsed by ten members, and include the offices of President, two vice-presidents and an Honorary Secretary. Anyone who has been a member of the Society for one year may be nominated.

La Revue Agronomique Canadienne

RÉDACTEUR—H. M. NAGANT

AVANTAGES ET DANGERS DE LA SCIURE DE BOIS COMME LITIERE

Une question à laquelle un agronome de la province de Québec est souvent dans l'occasion de devoir répondre est la suivante:

Peut-on recommander l'emploi de la sciure de bois, comme litière ou absorbant des déjections des animaux, à l'écurie ou à l'étable? Or, il est assez naturel que l'on éprouve une certaine hésitation à répondre dans l'affirmative à cette interrogation, d'ordre absolument pratique cependant, dans un pays où les multiples et importantes scieries produisent de grandes quantités de ce déchet dont peut disposer le cultivateur. S'il est vrai que la sciure de bois se distingue par une remarquable capacité d'absorption pour les liquides—l'expérience démontre, en effet, que cette matière peut en retenir environ quatre fois son poids—et constitue de ces fait un excellent facteur de conservation de l'urine du fumier de ferme, d'autre part, les praticiens lui reprochent souvent d'avoir une action délétère sur la fertilité du sol, aussitôt qu'elle intervient en quantités un peu considérables dans le fumier, et cela surtout si l'engrais s'applique aux terres légères. Jusqu'ici, les techniciens ont surtout attribué l'effet dommageable de la sciure de bois, aux matières antiseptiques qu'elle contiendrait; ces substances paralyseraient le développement de la flore microbienne du sol, aussi longtemps qu'elles n'auraient pas disparu par décomposition.

En se basant sur cette supposition, on pensait généralement qu'il y avait lieu de se défier davantage des déchets de bois résineux, à cause de leur forte teneur en hydro carbures terpéniques que l'on croyait plus particulièrement aptes à exercer cette action antiseptique dans le sol.

Des travaux récents, faits en Suède où l'emploi de la sciure de bois comme litière s'est largement répandu, depuis la guerre surtout, attribuent cette influence nocive, constatée fr quemment aussi dans ce pays, à une caus différente de celle soupçonnée jusqu'ici.

Suivant un rapport de H. G. Sonderbau et Chr. Barthell, résumé dans "Revue de Renseignements agricoles", de l'Institut In ternational d'agriculture de Rome (numér avril-juin 1925, p. 473) le mal serait plutô imputable à la destruction des nitrates, à l suite de la décomposition de la cellulose D'après ces agronomes, il suffirait d'une pro portion de 2% de cellulose dans le sol pou paralyser complètement le processus de l nitrification qui sans cela serait norma D'autre part, ils ont constaté qu'aussitôt qu la cellulose a été décomposée la dénitrifica tion cesse de se produire.

Un autre savant suédois, O. Arrhénius, cit comme exemple de l'effet déprimant que peu avoir l'emploi de la sciure de bois, le ca d'un établissement maraicher. Par suite d l'application d'un compost préparé avec le déchets d'une scierie voisine, les cultures de différents légumes, tels que tomates, salades fraises, etc., furent entièrement compromises

L'état de végétation des plantes indiquai clairement un manque d'azote assimilable au quel on ne put porter remède que par l'em ploi d'engrais azotés. La conclusion prati que à tirer de ces faits, c'est qu'il y a lie de se montrer fort prudent dans l'usage d la sciure de bois comme litière ou aborban des matières fécales des animaux.

Il est bien connu que la décompositio de la cellulose, que celle-ci soit à l'état d paille ou sous une autre forme, provoque l réduction des nitrates du sol; on sait, en effet que les dénitrificateurs sont particulièremen abondants parmi les bactéries qui s'attaquen à la cellulose dans les premières phases d la décomposition. C'est pourquoi on a recon nu depuis longtemps que les fumiers pail

leux, frais, provoquent une dénitrification active du sol.

Voilà un fait qui plaide en faveur d'une fermentation énergique du fumier avant son incorporation à la terre, lorsqu'il comporte une forte proportion de matériaux cellulosiques.

Il semble aussi assez naturel que le cellulose sous forme de sciure de bois est plus lentement décomposable que sous forme de paille ou autres matériaux absorbants. De là il faudra conclure que les fumiers contenant une forte proportion de déchets de bois devront subir une fermentation plus prolongée et plus énergique que les fumiers ordinaires, avant de pouvoir être appliqués sans danger pour la fertilité du sol.

CONCLUSION

Aussi, pour éviter tout mécompte, pour être assuré que la cellulose aura atteint un degré de décomposition ou d'humification assez avancé pour devenir inoffensive vis-à-vis des nitrates, il nous parait bien qu'on devrait donner les conseils suivants, aux cultivateurs qui peuvent avoir intérêt à user de la sciure de bois dans leurs étables et écuries:

1o. Ne pas employer des quantités excessives et l'associer plutôt à une certaine proportion d'autres matériaux plus fermentescibles, afin d'en rendre la décomposition plus facile.

2o. Ne faire usage de la sciure de bois que durant la première période de stabulation hivernale des animaux, par exemple, pendant 3 ou 4 mois seulement sur les 6 mois d'hivernement total. Ainsi, au printemps la partie du fumier relativement frais et peu fermenté ne contiendra pas de sciure de bois, laquelle aura eu le temps d'achever sa décomposition dans l'engrais de formation plus ancienne.

3o. Favoriser une fermentation énergique du fumier à base de déchets de bois, en l'empilant en gros tas fortement tassés et maintenus humides.

Il semble évident, qu'en l'occurence, l'épandage direct sur la neige ou la distribution en petits tas, sur le champ, est une pratique qu'il faut particulièrement éviter, puisqu'elle met, avant tout, obstacle à la décomposition des litières.

H. M. NAGANT

A Travers les Revues

LE ROLE DE L'ALUMINIUM DANS LA VIE DES ORGANISMES

Jusqu'ici, l'opinion courante parmi les autorités en matière de chimie biologique, tenait l'aluminium pour un élément inutile dans le métabolisme végétal, et si on en constatait parfois la présence dans les cellules des plantes, elle était considérée comme purement accidentelle.

Voilà encore une conception qu'il faudra modifier s'il faut en croire le professeur, Dr. Jules Stoklasa, Directeur bien connu de la Station expérimentale pour la production végétale à Prague, qui publie un article original, sous le titre indiqué plus haut, dans le numéro de Juillet-Septembre 1925 de la "Revue internationale de renseignements agricoles", publiée par l'Institut International d'Agriculture de Rome. "Mes études personnelles, ainsi que celles de mes collaborateurs, affirme le savant biologiste tchéco-slovaque, ont fourni la preuve que, tout au contraire, l'aluminium joue un rôle important dans les fonctions physiologiques des plantes de certaines familles."

Il nous serait impossible d'exposer les considérations techniques qu'émet l'auteur, sur le comportement de l'aluminium vis-à-vis d'autres éléments, tels que le fer et le manganèse, qui peuvent pénétrer dans la plante, ou de suivre les discussions qu'il entame concernant le rôle des composés alumineux dans les réactions chimiques du sol et les phénomènes de l'acidité, sans transcrire intégralement tout l'article. C'est pourquoi nous voulons nous borner aux observations suivantes, d'ordre essentiellement pratique, qui ressortent de cette étude.

Les plantes *hygrophytes*, c'est-à-dire aimant l'eau, se distingueraient par la forte proportion d'aluminium qu'elles contiennent. Chez ces plantes, le métal en question se localiserait surtout das les organes souterrains, tels que

racines, bulbes, rhizomes et tubercules pour les plantes supérieures. Il s'en accumulerait également dans les matières de réserve de leur semences, tandis que le reste de la partie épigée en renfermerait beaucoup moins.

Les plantes *xérophytes* au contraire, c'est-à-dire qui affectionnent la sécheresse et poussent de préférence sur les sables des bords de la mer, dans les steppes, dans les prairies et les déserts seraient caractérisées par leur faible teneur en aluminium.

Quant aux végétaux *mésophytes*, ou du type intermédiaire, qui accordent leur préférence à un sol et une atmosphère modérément humides, ils seraient, suivant l'auteur, très pauvres en aluminium lorsqu'ils croissent dans un endroit sec et en contiendraient des quantités considérables surtout dans leurs racines, quand ils ont cru sur un sol humide et marécageux.

Parmi les effets spécifiques attribués à l'aluminium, le directeur de la Station expérimentale de Prague mentionne surtout celui de contrebalancer l'action délétère des composés du fer qui ont une tendance à s'accumuler dans les cellules des plantes croissant en terrain humide.

Relation entre l'aluminium et les matières colorantes végétales et animales

D'après Stoklasa, l'aluminium prendrait une part active à la formation des pigments de la fleur. Nos expériences, dit-il, nous ont permis de reconnaitre que l'aluminium exerce, avec le fer et le manganèse, une grande influence sur les matières colorantes diluées dans le jus des cellules de la fleur. Ce sont ces trois éléments qui non seulement déterminent l'intensité du coloris, mais provoquent aussi les changements de coloration des fleurs blanches et roses en rouge ou en bleu et violet, ainsi que les variations du jaune au rouge. Le même métal aurait aussi un rôle considérable dans l'apparition des pigments chez les animaux. Les expériences indiqueraient que les pigments bleus, violets et bleu verts chez les coléoptères et les oiseaux sont plus riches en aluminium que les autres matières colorantes. La comparaison de la composition des couleurs dans les trois règnes: minéral, végétal et animal, prmettrait de conclure que l'aluminium joue un rôle encore mystérieux aujourd'hui dans la formation des couleurs éclatantes. Absorbé du sol par les racines, il déterminerait chez les plantes une magnifique floraison de teintes rouge, bleu et violette.

Enfin, l'aluminium des plantes, en faisant sa migration dans le règne animal, prendrait part au développement des coloris des plus beaux et les plus délicats que l'on puisse trouver chez les animaux. Les analyses prouveraient aussi qu'on trouve l'aluminium à côté du fer dans l'hémoglobine du sang.

Rôle attribué à l'aluminium dans l'exubérante végétation de la Période Carbonifère

Ensuite l'auteur fait observer que certaines cryptogames, les mousses formatrices de tourbe (sphaignes) notamment, ont une antipathie spéciale pour le phosphore, le potassium et quelquefois aussi pour le calcium. Remarquons d'ailleurs que ceci semblerait être en accord avec la pauvreté bien connue de la tourbe en ces éléments minéreaux. D'autre part, le milieu nutritif dans lequel prospèrent ces plantes contiendrait en quantités considérables du fer, de l'aluminium et du soufre sous forme de sulfate de fer. En l'occurrence, le rôle de l'aluminium serait non seulement d'empêcher l'action nocive du fer, mais encore d'entraver l'absorption du potassium et du phosphore afin de protéger la transformation normale des matières et de l'énergie dans la plante. Il en résulte donc que l'aluminium, qui se trouverait sous forme d'humates dans ces sols tourbeaux, agirait comme agent régulateur de l'absorption des ions divers, par les racines de la plante.

Or, comme le fait remarquer Stoklasa, le monde végétal qui a contribué à la formation des gisements de houille de la Période Carbonifère était constitué essentiellement de cryptogames se reproduisant dans des marécages ou terrains humides, à la faveur d'un climat doux, uniforme et sans gelées. Ces cryptogames fossiles appartenant principalement aux familles des équisétacées, des lycopodinées et des fougères étaient donc des plantes qui absorbaient relativement beaucoup de silicium, d'aluminium et de fer, et ne consommaient que peu de P_2O_5 et de K20.

De plus, continue plus loin l'auteur de cette étude: "Nos expériences ont démontré qu'une accumulation excessive du potassium et du phosphore aurait pu nuire à l'essor la végétation dans ces temps reculés. C'est donc

'intervention physiologique de l'aluminium qui a dû modifier ces circonstances défavorables et permettre le développement féérique de la flore d'autrefois. Il faut en conclure, ajoute-t-il, que, *sans l'aluminium, les houillères n'existeraient pas aujourd'hui.* Après cela, le savant professeur fait encore remarquer que la végétation si merveilleusement luxuriante, qui a produit nos charbons fossiles de toutes espèces, se serait développée sous l'influence de conditions extrêmement favorables pour sa croissance et grâce à une radioactivité très forte du sol et de l'atmosphère. On constatera aussi, continue-t-il, que c'est pendant les époques géologiques dont les roches démontrent une forte radioactivité que la végétation a pris des dimensions énormes, tandis qu'au contraire, les périodes caractérisées par des roches non radioactives, comme celles de formation crétacée, n'ont produit aucun gisement de houille.

Voilà certainement des théories extrêmement intéressantes, si elles peuvent paraitre assez hardies et révolutionnaires dans le domaine de la physiologie végétale où le mystère, l'incertitude et les problèmes se rencontrent encore à chaque pas.

Cependant il nous sera bien permis de faire observer en terminant ce résumé de la remarquable étude du savant professeur, que dans son affirmation relative à l'influence de la radioactivité sur le développement des prodigieuses végétations qui ont donné naissance aux gisements houillers, il semble perdre de vue que dans l'Ouest du continent américain, et dans notre province d'Alberta notamment, existent de formidables dépôts de charbons fossiles qui relèvent de la fin de la Période Crétacée. Ceci, évidemment, ne semble pas concorder tout à fait avec son dernier avancé.

Remarquons enfin, qu'une note de la rédaction de la "Revue internationale des Renseignements agricoles" signale qu'une étude détaillée, de Jules Stoklasa, sur la diffusion de l'aluminium et sur son importance pour la diffusion de l'aluminium et sur son importance pour la croissance et le métabolisme des plantes a été publiée à Iéna (Allemagne) par le libraire-éditeur Gustave Fischer, que cette étude a produit une grandé impression et a attiré l'attention de tout le monde savant.

H. M. NAGANT

Bibliographie

"NOTES DU COURS DE GEOLOGIE AGRICOLE"

M. H. M. NAGANT, I.A., I.F.

Monsieur Nagant offre cette année à ses élèves et, pourquoi ne pas l'ajouter, à tous ses anciens élèves, une première édition miméographée de son Cours de Géologie. C'est plus qu'une adaptation, c'est une refonte du cours donné jusqu'ici oralement. Dans son avant propos, l'auteur, avec beaucoup de modestie, ne parle que de notes: "En rédigeant ces notes de Géologie, notre intention est de fournir aux étudiants un canevas aussi réduit et méthodique que possible, des principes de géologie qu'il faut posséder à titre de science fondamentale d'un cours d'Agronomie". Pourtant, la bibliographie qui fait suite à ce passage, bien que n'étant que partielle, des sources utilisées dans l'élaboration du présent travail, annonce autre chose qu'un "canevas". Une vue rapide du plan montrera un solide Cours de Géologie agricole, bien divisé et pourvu d'une table détaillée des matières:

1. GEOLOGIE STRUCTURALE, qui s'occupe de l'arrangement des parties constitutives de l'écorce terrestre.

2. GEOLOGIE DYNAMIQUE, qui étudie cet ensemble de forces sises à la surface ou dans l'écorce de la terre et qui en font un siège de modifications incessantes.

3. GEOLOGIE STRATIGRAPHIQUE; particulièrement intéressante au point de vue agricole, cette partie nous révèle la valeur de notre large secteur de croute terrestre canadienne. Il est difficile de reprocher à nos géologues du Canada, de négliger l'étude superficielle de notre pays, pour s'attarder, suivant l'ordre classique, à décrire les terrains en profondeur. Partant de cette immense pénéplaine de 2,000.000 de milles carrés qu'est le Bouclier Canadien, si nous nous dirigeons vers l'Atlantique ou le Pacifique, nous passerons sur la tranche de toute la suite des terrains, s'étageant parfois avec

une parfaite régularité. Ces tranches sont souvent très épaisses; Adams et Barlow disent en avoir mesuré une, dans le seul Grenville, de 94.000 pieds de large, dont plus de la moitié de calcaire, ce qui constitue la plus importante formation sédimentaire connue au monde. Non content de décrire ainsi les terrains de surface, M. Nagant, dans ses "caractères agrologiques", qui ne seront jamais trop longs ou trop nombreux, souligne la composition chimique des sols. La lecture du texte, en maints endroits, nous fait bien sentir que le point de vue de l'auteur est le nôtre.

Pratique encore est ce Cours par sa façon prudente de passer près des brulantes controverses biologiques sans y toucher; deux lignes sont consacrées à l'hypothèse de "l'évolution des êtres", plus un exemple; et trois à celle des "migrations", plus un exemple. On parle incidemment" du fameux Eozoon Canadense, lequel donna lieu à tant de discussions"; dans la série Steeprock, (Huronien inférieur) on mentionne les traces de fossiles, chacun sait que ce sont des spongiaires, mais leur nom harmonieux Atikokania Lawsoni Walcott est passé sous silence.

Par contre, une attention toute particulière est accordée aux ressources minières de chaque période. Pratique, ce traité ne cesse pas d'être scientifique pourtant; sa partie, à mon humble avis, la plus originale à ce point de vue, est la brève étude qui précède la description du Primaire, et qui nous donne les notions de Paléontologie nécessaires à l'identification des fossiles de chaque période. Ainsi, après la description des diverses formations cambriennes, l'auteur, adoptant une marche qu'il a suivie dans toute cette partie de géologie historique, parle, pour le Québec en particulier, de la vie durant le Cambrien, l'Ordovicien, le Silurien. . .C'est une application immédiate des notions précédentes.

Le Cours se termine par un excellent exposé du Quaternaire, le plus intéressant et le plus complet que je connaisse pour le Canada. Un effort, joliment réussi, a été fait avec schéma et tableaux, pour mettre un peu d'ordre dans cette période, plutôt dans ces périodes glaciaires et interglaciaires à centres multiples. L'étude de la période Champlain est originale et très satisfaisante. L'histoire de la mer Champlain, et surtout celle du lac Ogibway, moins connue, donne à nos terres neuves de l'Abitibi et du Témiscamingue, de toute cette partie du Nord-Ontario et du Nord-Ouest de la Province de Québec, leur vraie valeur. Le lac Ogibway a déposé, en ces lieux où règne le granit, une vaste "Clay-belt", ayant une surface de 68.000 milles carrés, plaine de limon arable d'une épaisseur moyenne de 25 pieds.—C'est une richesse qu'il ne faut pas mépriser.

En résumé, ce Cours présente un travail personnel important. La connaissance des principes que l'auteur y développe, est nécessaire à quiconque veut faire de l'agriculture scientifique, et c'est pourquoi nous conseillons aux lecteurs de cette Revue de prendre connaissance de cette publication d'un des nôtres.

P. Ls-M.

On peut se procurer ces notes, au prix de $1.00; par la poste: $1.10. S'adresser au Secrétaire, Institut Agricole d'Oka, La Trappe, P.Q.

ACTIVITES DES SECTIONS

Section de Ste Anne de la Pocatière

Nous sommes informés que cette section a tenu un goûter-causerie le mardi 16 février, à sept heures trente de l'après-midi. La réunion a eu lieu à l'Ecole d'Agriculture de Ste Anne de la Pocatière et le conférencier fut monsieur Jean-Charles Magnan, Agronome de Portneuf.

Verticillium Wilt of the Red Raspberry.[1]

G. H. BERKELEY and A. B. JACKSON

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In 1923 the presence of this disease in On-rio, Canada, was reported for the first time y the authors (1) under the title "Blue Stem f the Red Raspberry". In that year a few lantations throughout the Niagara Peninsula ontained as high as 20% infection. In 1924 survey throughout South Western and South astern Ontario demonstrated that this dis-ase was present to some extent in most rasp-erry growing sections.

In 1912 Lawrence (14) described a disease f black raspberries which he called "Blue tem". The causal organism was given as *crostalagmus caulophagus*, Lawrence, which in reality a *Verticillium* sp. as has been ointed out by Carpenter (5). The disease ncountered on red raspberries in the Nia-ara Peninsula in 1923 bore many similarities the Blue Stem on black raspberries and hen the causal organism was likewise found be a *Verticillium*, the disease on red rasp-erries was described as "Blue Stem". How-ver it is now considered advisable to use the rm "Wilt" since "Blue Stem" is the term ommonly applied to a disease of raspberries f the virus type. Moreover since the strik-ng characteristics of this disease are a yel-owing, drooping, and "wilting" of the leaves, seems more appropriate to use the term wilt". Harris (9) recently reporting this isease for raspberries in England designates e disease as "Blue Stripe Wilt" of raspber-es. But since the blue discoloration may ntirely girdle the cane (therefore no stripes) nd also since the blue discoloration may be ntirely lacking from defoliated canes, the se of "blue stripe" does not seem appro-riate under Ontario conditions. We are erefore designating it "wilt" since this cor-ectly describes the outstanding symptoms of e disease.

"Wilt" has been found during the past ree years on:—Cuthbert, St. Regis, Marl-oro, Viking, Herbert.

Other varieties are possibly equally as sus-eptible as the above, but this has not as yet been determined due, largely, to their being so little grown in Ontario. Harris (9) gives the following varieties for England:—Bath's Perfection, Red Antwerp B, Prior's Prolific, Mitchell's Seedling, Red Antwerp A, Banniforth A, Banniforth B, Reeder's Perfection.

Literature

The first description of a *Verticillium* sp. infecting raspberries was recorded in 1912 by Lawrence (14) under the title "Blue Stem of the Black Raspberry"; the causal organism was given as *Acrostalagmus caulophagus*, Lawrence. Carpenter 1918 (5) pointed out that the genus *Acrostalagmus* should be united with the genus *Verticillium*, since there is a section of the genus *Verticillium—Gliocephalum Sacc.* 1886—set aside for forms where the conidia are held together by mucus in heads. At the present time therefore, this form recorded by Lawrence may be designated *Verticillium caulophagum*.

Rankin (16), Hunt (11), Hockey (10) and the authors (1) have reported "Blue Stem" of black raspberries in New York, Washington, and the Niagara Peninsula, Ontario, respectively.

The authors (1) in 1924 reported for the first time in Ontario, "Blue Stem" on red raspberries. The causal organism was a *Verticillium.*

Harris (9) 1925 reported "Blue Stripe Wilt" of raspberries for England. The causal organism was a *Verticillium.*

Distribution and Seriousness of the Disease

During 1923 "wilt" was found generally throughout the Niagara District, averaging around 5% in the plantations inspected, with several showing 20% infection. In Western Ontario more of this disease is found than in Eastern Ontario. Very few cases were ob-

(1) First reported by the authors at the annual meeting of the Canadian Phytopathological Society held at Queen's University, Kingston, 1923, and later appeared as an abstract in Phytopathology, Vol. 14, p. 347, 1924.

served East of Oshawa. The disease is not as yet of major importance, but it appears to be on the increase.

Cases have been observed where every cane in a hill was diseased and where eventually the whole hill was killed. In general however the disease is not so severe, and although some or all of the canes in a hill may be killed, new shoots arise from the underground roots that escape infection, at least for a time. This has been repeatedly observed in the field. The presence of this disease in the plantation occurs generally in patches, and although severe one year may be followed the next by a mere trace. In 1923 three large plantings of Cuthberts had as high as 20% "wilt". In 1924 and 1925 only a trace of "wilt' could be found in these plantations, although the grower made no effort whatever to effect control.

Since this disease is now wide spread throughout most sections of Ontario and since it causes considerable financial loss from (1) loss of crop from fruiting canes of the current year, (2) reduction of fruiting canes for next year (and hence crop) and (3) in a general lessening of vitality of the bushes making them susceptible to winter injury and other diseases, the growers of Ontario a urged to familiarize themselves with tl comparatively new disease, and in the s ting out of new plantings to practice t preventive measures outlined under contr

Symptoms

The disease first becomes apparent in t field by a yellowing and wilting of the lo er leaves. The yellowing is first appar as irregular patches between the main vei which is soon followed by a more gene discoloration and the drying and curling u ward of the margin of the leaf (Fig. 1). T leaves then droop and finally become deta ed from the cane. This discoloration, wi ing, and casting of the leaves progresses fr the ground line upward. As a result the fected cane becomes defoliated, with the p sible exception of a tuft of small, browni leaves at the extreme tip which may adh tenaciously for some time (Fig. 2). G erally accompanying this wilting and casti of the leaves is a discoloration of the ca hence its former name "Blue Stem". T discoloration may be present as stripes sta ing from about the ground line and clos following the upward progress of defol

Fig. 1. Raspberry Wilt.
Fig. 2. Defoliation caused by Raspberry Wilt.
Fig. 3. Healthy Plant (left); Inoculated Plant (right). Note shrivelled buds on lower half of inoculated cane.

on, or it may cover the entire circumference the cane. Canes have been observed with ntinuous or partial stripes up one side or th sides, or else completely girdled by the ue discoloration (hence no stripes). On e other hand numerous diseased canes have een observed which have shown no signs hatever of the blue discoloration, although ey had been defoliated, under field condions, for some time. Such canes when sec- oned and examined showed the presence of ycelium in the wood elements, and isola- ons made therefrom, gave practically pure ltures of *Verticillium* sp. The blue dis- loration, although generally present, may lacking. Therefore the important strik- g and constant symptom is a yellowing, ilting, and casting of the leaves. In late ll and winter "wilt" in a plantation may ascertained by the presence of dead canes, by the presence of small, shrivelled un- veloped buds on the cane. (Fig. 3). Of urse, all dead canes are not necessarily due "wilt", but in a plantation where "wilt" s been prevalent dead canes are plentiful. anes that have gone into the winter condi- on apparently healthy, although recently in- cted with this disease, may be killed, so that) the buds will not unfold in the Spring,) only the buds on certain sections will un- ld, or (3) may leaf out quite normally in hich case the leaves and laterals are dwarf- l and any fruit formed is small and taste- ss. More often such canes lose their leaves d die before fruiting time.

Pathogenicity

Isolations from diseased canes invariably oduced almost pure cultures of *Verticillium* . The isolations were made as follows:— rst the diseased cane was liberally painted th corrosive sublimate, and then by means a flamed scalpel the cortex was cut away d a small section of the wood tissue was en transferred, under aseptic conditions, a culture tube. With this method pure ltures of *Verticillium* generally resulted. onosporic cultures were then obtained and oculations made into healthy raspberry and mato plants in the greenhouse. In about ur weeks' time the first symptoms of the sease appeared and eventually the raspberry ne became defoliated (Fig. 3). The toma- plants inoculated with the raspberry *Verticillium* also showed wilt symptoms. Isolations from the inoculated canes gave back the same *Verticillium* sp. Duplicate inoculation experiments were carried out in the winter of 1924 and 1925 with positive results in all cases. In all some twenty raspberry plants were inoculated. Various methods for inoculating the raspberry plants were tried such as (1) soil inoculation by means of spores and mycelium, (2) immersion of the roots of three to four inch suckers in a spore suspension before planting, and (3) making a slit in the cane at or below the ground line. This last method proved more satisfactory and was effected by making a slit in the cane just below the ground line and placing therein a small piece of the mycelium of the fungus from a monosporic culture growing in a culture tube. The slit was then covered with moist absorbent cotton. The inoculated plants were not put in a moist chamber of any kind but were left uncovered on the bench. Both young suckers and year old canes were thus inoculated, with positive results. The checks in all cases remained healthy. The Cuthbert variety was used throughout in the inoculation experiments.

Cultural Studies

MATERIAL:

The *Verticillium* sp. described in this paper as being the cause of raspberry "wilt" was isolated from some fifty raspberry canes secured from various parts of Ontario; and in most cases pure cultures of *Verticillium* sp. resulted. In some few instances there was contamination by *Fusarium* and *Botrytis* sp. Throughout the remainder of this paper, this form will be designated *Verticillium (raspberry)* until it is named and given specific rank.

A culture of *Verticillium albo-atrum* (R. & B.) was kindly sent the authors by J. H. H. Van der Meer, from Holland. A culture of *Verticillium Dahliae* (Klebahn.) isolated from Dahliae, and identified by Klebahn, and also a culture of *Verticillium albo-atrum* were obtained from the Centraal-Bureau voor Schimmelcultures, Baarn, Holland.

Monosporic cultures of all these forms were obtained by the micro-dilution method(1) so that comparative studies might be undertaken.

(1)Method previously described by Senior Author in "Transactions of the Royal Canadian Institute", Toronto. Vol. XV. Part 1. p. 120, 1924.

CULTURE MEDIA:

Potato and potato dextrose agars as well as peptone dextrose, peptone lactose, nitrate dextrose and nitrate lactose synthetic agars were used as media. The basic composition of the synthetic agars was:—

Monopotassium phosphate	1 gm.
Magnesium Sulphate	0.25 gm.
Ferrous Sulphate	0.15 gm.
Sodium Chloride	0.005 gm.
Water	1000 cc.

To this was added the carbohydrate and nitrogen source, as specified in the name of the medium, in the following amounts:—peptone 20 gms, nitrate 15 gms, dextrose 30 gms, lactose 30 gms. This was sterilized in the autoclave at 15 lbs. pressure for 15 minutes. Two per cent agar was used with peptone dextrose and peptone lactose; but three per cent was found to be necessary for the nitrate dextrose media.

The following amounts were used for the potato medium:—

Potato (cut fine)	300 gms.
Water	1000 cc.

This was autoclaved at 15 lbs. pressure for 20 minutes, filtered through several folds of cheesecloth, made up to 1000 cc., solidified with 20 gms. of agar and resterilized in the autoclave at 15 lbs. for 15 minutes.

For the potato dextrose agar 15 gms. of dextrose per litre was added to the above medium.

The description of *Verticillium (raspberry)* will be given as cultured on potato dextrose, peptone dextrose and nitrate dextrose agars only, since the growth on peptone lactose, nitrate lactose, and potato adds nothing of special interest. The following terminology is used throughout:

aerial mycelial=mycelium of fluffy, aerial type.

surface-loving mycelial = mycelium that grows only on the surface of the medium and does not appreciably project itself upward.

raised mycelial=mycelium is intermediate between surface loving and aerial. It is raised above the surface of the medium as a fairly compact, continuous mass.

POTATO DEXTROSE AGAR:

Fourteen day old cultures incubated at 22°C to 24°C. show a fine, surface-loving to raised mycelial growth somewhat loose [illegible] texture. Tufted aerial mycelium occurs [illegible] patches. The surface of other than aerial se[illegible]tions, is continuous and smooth. Any tim[illegible] after eight to ten days a blackening of th[illegible] culture below, on, or just above the surfa[illegible] of the medium takes place. This darkenin[illegible] of the culture continues until finally it is [illegible] complete black sclerotial crust. Microscop[illegible] examination shows a copious production [illegible] the typical, verticillately-branched conidi[illegible]phores of the genus *Verticillium Nees.* T[illegible] conidiophores are not apparent as such to th[illegible] naked eye as is the case with *Botrytis* an[illegible] other Genera, but are intermixed with an[illegible] are a part of the general mycelial growt[illegible] The conidia, although born singly at the ap[illegible] of the branchlets, are, however, held togeth[illegible] in spherical heads by means of mucus. Chai[illegible] of chlamydospores, simple or branched, an[illegible] numerous micro sclerotia make up the blac[illegible]ened portion of the culture. The conidia a[illegible] oval to globoid, $2\frac{3}{4}$–$6\frac{1}{4}\mu$ long and $1\frac{1}{4}$–$4\frac{1}{[illegible]}$ wide. The conidia are not only formed [illegible] the apices of the whorled conidiophores, b[illegible] are found also on the tips of short side bra[illegible]ches that occur almost anywhere on the m[illegible]celium. The conidiophores vary greatly [illegible] length, from 20μ to 400μ.

PEPTONE DEXTROSE AGAR:

Fourteen day old cultures on this mediu[illegible] produce a compact, white, continuous, rais[illegible] mycelial growth of fine texture, and bla[illegible] sclerotia. Later however, when the cultu[illegible] is about four weeks old a very scanty produ[illegible]tion of sclerotia may take place. At no tim[illegible] however, is it sufficient to show through t[illegible] mycelium, as in the case of potato dextro[illegible] medium, but to be seen must be looked [illegible] from the underside. A plentiful producti[illegible] of the typical, verticillately-branched conid[illegible]phores and conidia on side branches of t[illegible] mycelium is generally present.

NITRATE DEXTROSE:

After fourteen days, cultures on this me[illegible]ium show white, arachnoid, surface-lovi[illegible] mycelial growth with generally a slimy, yea[illegible] like appearance; sclerotial formation appea[illegible] as black, pin-point growths scattered on a[illegible] just below the surface of the medium. Co[illegible]idiophores and conidia are abundant. La[illegible] the culture becomes a continuous black scle[illegible]tial crust.

ig. 4. Types of conidiophores—(a) Simple, (b) Compound, (c) Branchlets from mycelium.

ENERAL DISCUSSION:

All cultures irrespective of medium start ut as surface-loving mycelium. On peptone extrose this increases greatly in amount and ecomes thick, compact, and aerial in nature o that sclerotia are completely covered by his blanket of thick, tissue-like mycelium. Iowever, sclerotial production on this medium is often lacking and always extremely scanty. On potato dextrose and nitrate dextrose the surface-loving mycelium is soon outstripped by the rapid production of sclerotia, which later forms an almost continuous sclerotial crust over the entire surface of the medium, giving the culture a coal black character.

The conidiophores in all cultures are of three types namely: (1) verticillately-branched and simple (Fig. 4a); (2) Verticillately-branched but compound (Fig. 4b), and (3) single, short side branchlets from vegetative mycelium (Fig. 4c). The whorled conidiophores vary in length from 20μ to 400μ, with 1 to 5 branches in a whorl. The side branches (both those from the whorled conidiophores and from the vegetative mycelium) vary from 13 to 35μ in length. The heads of spores vary from 6 to 30μ in diameter with 12u as a fair average.

The black of the culture is composed mostly of micro sclerotia, (Fig. 5) although simple and branched chains of chlamydospores are also present (Fig. 6).

Taxonomy

It will be necessary at this point to consider the most important literature relating to *Verticillium* sp.

The first description of a *Verticillium* sp. parasitising the wood elements of a plant was given by Reinke and Berthold in 1879 for the "Kräuselkrankhiet" of potatoes. They

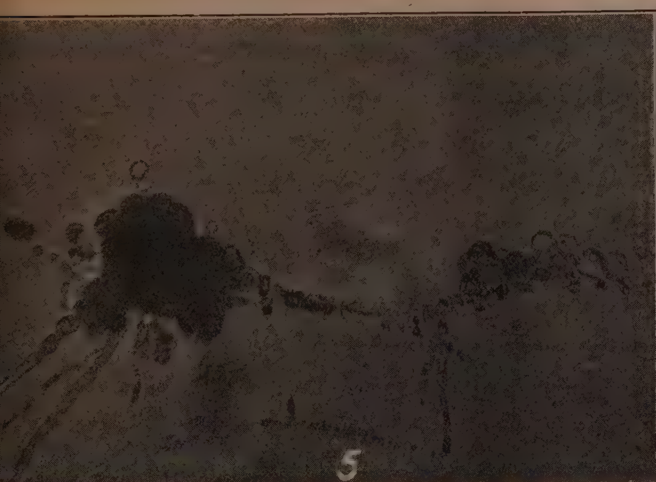

Fig. 5. Photomicrograph of Sclerotia.

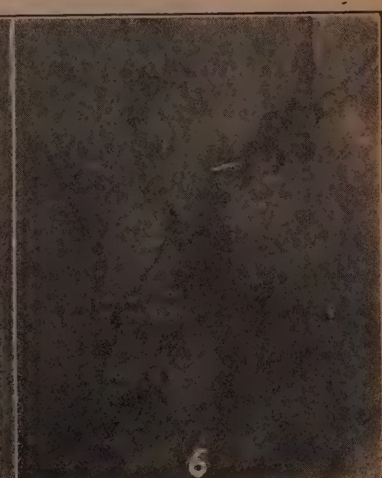

Fig. 6. Photomicrograph of Chlamydospores.

named the fungus concerned *Verticillium albo-atrum* and in their description make no mention whatever of micro sclerotia or sclerotial crusts, but point out that the blackening of the culture is due to blackened, septate, somewhat swollen hyphae "Dauermycelium". Conidia 6 to 12μ by 3μ.

Lawrence (1912) was the first to describe a form of *Verticillium* parasitic on black raspberries. The darkening of the culture in this case was due to a copious production of chlamydospores, and dark colored mycelial branches. "The spherical to oblong chlamydospores 7μ to 12μ in diameter remain attached in chains". The resting condition of this fungus *Verticillium caulophagum* closely resembles the description given for *Verticillium albo-atrum* R. & B. The size of the conidia however, ranges from 3 to 7.5μ x 2 to 3μ.

Klebahn (1913) described the *Verticillium* isolated from dahlia as a new species *Verticillium Dahliae*, Klebahn. In this form the darkening of the culture was effected by micro sclerotia, not darkened mycelium or chlamydospores. It was largely on this basis that he designated the form from dahlia a new species.

Wollenweber (19), Carpenter (4), Bewley (3), Haenseler (7), and others have considered forms of *Verticillium* isolated from potato, okra, egg plant, tomato, peach as *Verticillium albo-atrum* notwithstanding the presence of micro sclerotia was described and figured (Carpenter).

Pethybridge (15) is of the opinion that the blackening of the cultures of *Verticillium albo-atrum* is due entirely to the blackening of the mycelium. There are no micro sclerotia.

Jagger and Stewart (12), Zimm (20), and Edson and Shapovolov (6) point out a difference in cultures of *Verticillium* sp. in that one type shows the presence of sclerotia while in the other the blackening of the culture is due to darkened mycelium.

Recently, Van der Meer (18) in an extended study of *Verticillium* sp., separates the parasitic forms of *Verticillium* into two groups. In group A (the albo-atrum type) the blackening of the culture results from darkened mycelium, while in group B (Dahliae type) micro sclerotia are responsible for the blackening of cultures. He places in Group A forms isolated from cucumber, cherry, to mato and potato, while in Group B are foun forms isolated from nineteen ornamenta plants, six weeds, red currant, black curran gooseberry, lilac, Prusus Mahaleb, morell sugar beet, melon, tomato and potato. Bot *Verticillium albo-atrum* and *Verticilliu Dahliae* have been found on potato and to mato.

This resumé of a part of the literatu points out that the present confused state i the Genus Verticillium is largely due to di ferent interpretations of the original de cription of *Verticillium albo-atrum* as describ ed by Reinke and Berthold.

The authors have been studying in cultur for the last three years some fifteen strain of *Verticillium* isolated from such hosts a raspberry, potato, tomato, maple, barberr and aster which readily permit of being sep arated into the same two groups as outline by Van der Meer. One of these culture *Verticillium* 1245, isolated from potatoes co lected at Sault Ste. Marie, produces a copiou supply of darkened resting mycelium whic gives the culture a black appearance. (Fi 7). Micro sclerotia or sclerotial crusts a entirely absent. Another culture, No. 124 isolated from cherry and obtained from H. H. Van der Meer, is of this same type. A the other cultures, including the "wilt" o ganism of raspberry, produce chlamydospor (Fig. 6) and sclerotia (Fig. 5) to a greate or less extent but there is no discoloration the mycelium as occurs in 1245 or 1246. T authors therefore agree with Van der Meer that these forms should be separated into tw groups, (1) Group A. where the myceliu blackens, (Fig. 7) and (2) Group B. whe micro sclerotia are formed, (Fig. 5). C

Fig. 7. Darkened resting mycelium.

his basis it would follow that many of the orms originally described as *Verticillium lbo-atrum* such as *Verticillium albo-atrum* rom okra, egg plant, potato, Gossypium, Anirrhinum (Carpenter), tomato (Bewley), hould be transferred to the Dahliae group on ccount of the production of sclerotia by these orms.

Since *Verticillium (raspberry)* produces clerotia in abundance, it must of necessity lso be placed in Group B., with *Verticillium)ahliae* Klebahn, as the original standard. Iowever, a careful comparative study of culures of *Verticillium Dahliae* Klebahn (orignal identified by Klebahn) and *Verticillium raspberry)* has shown that *Verticillium raspberry)* is different in several respects to *'erticillium Dahliae.* In the first place, six lay old cultures of *Verticillium Dahliae* are onsiderably blackened by the presence of nicro sclerotia, whereas no blackening is apiarent in cultures of *Verticillium (raspierry).* On nitrate dextrose agar, ten day old ultures of *Verticillium (raspberry)* show the resence of micro sclerotia, whereas such do iot appear in *Verticillium Dahliae* until afer twenty days. This points out a physiolgical difference between these two forms ince *Verticillium (raspberry)* forms sclerоia first on nitrate dextrose agar, while *Vertiillium Dahliae* forms sclerotia first on poato dextrose. Secondly the mycelial growth f *Verticillium Dahliae* is of a dense, comact, grayish white (due to the presence of clerotia showing through the mycelium) erial type, whereas the mycelial growth of *'erticillium (raspberry)* is more surfaceoving in character, white, thin and loose in exture. Aerial mycelium is generally preent more or less, but is thin and somewhat ufted. That is, several strands appear to row upwards like one, as though held toether by moisture. The aerial mycelium is iot copious for either *Verticillium Dahliae* or *'erticillium (raspberry)* and is generally nly 2 mm. in the case of *Verticillium)ahliae* and 2 to 3 mm. for *Verticillium (raspierry)*, above the surface of the medium. The ufted nature of the aerial mycelium is preent in both forms, but considerably more ronounced in *Verticillium (raspberry).*

As the cultures become older it is someimes difficult to distinguish between the two orms since both become covered with a sclerotial crust, but *Verticillium (raspberry)* generally shows the presence of tufts of white mycelium resting on the sclerotial crust, which for the most part are lacking in cultures of *Verticillium Dahliae.*

Thirdly, a copious supply of whorled conoidiophore is somewhat longer in *Verticillcillium (raspberry)*, whereas such are very scarce in *Verticillium Dahliae.* In other words a greater percentage of conidia is formed on short side branches of the mycelium in *Verticillium Dahliae* than in *Verticillium (raspberry).* In addition the length of the conidiophore is somewhat longer in *Verticillium (raspberry).*

Fourthly, the difference in conidia between the two forms is not so much one of size as it is of shape. The spores of *Verticillium Dahliae* are much more elongate (cylindrical) than those of *Verticillium (raspberry)* which tend to be oval to globoid. Spores of both shapes are found in both cultures but the elongate spore is rare in *Verticillium (raspberry)* and the globoid spore is scarce in *Verticillium Dahliae.* This is clearly brought out in Fig. 8, which gives in the form of a graph a comparison in length on the one hand, and width on the other, of the conidia of both forms. The dimensions and shape of the conidia are—in *Verticillium Dahliae*, oblong to almost cylindrical, 3-7μ by 1.5-3μ; in *Verticillium (raspberry)* ovate to globoid, $2\frac{3}{4}$-$6\frac{1}{4}\mu$ by $1\frac{1}{4}$-$4\frac{1}{4}\mu$.

Therefore the differences as just noted above justify the conclusion that *Verticillium*

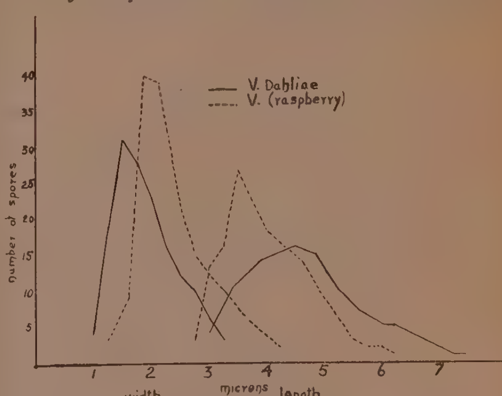

Fig. 8. Curves showing dimensions of conidia of *Verticillium Dahliae* and *Verticillium* (raspberry). 250 spores of each form were measured for the above curves.

(raspberry) is dissimilar to *Verticillium Dahliae.*

However, not only is it necessary to compare *Verticillium (raspberry)* with *Verticillium Dahliae*, since *Verticillium Dahliae* is the original standard of the sclerotia-forming type, but in addition its relationship with *Verticillium caulophagum* must likewise be ascertained, since both forms have been isolated from, and each is the cause of, a "wilt" disease of raspberries. In the description given by Lawrence for *Verticillium caulophagum* no mention is made of micro sclerotia, but he states that the blackening of the culture is due to "strands of chlamydospores and the dark colored mycelial branches". This form, therefore, does not belong to the *Dahliae* group and is fundamentally different from *Verticillium (raspberry).*

Therefore since *Verticillium (raspberry)* is dissimilar to *Verticillium caulophagum* as well as to *Verticillium Dahliae*, the authors propose the following specific name and description:

VERTICILLIUM OVATUM nov. sp.

Parasitic in the canes and petioles of Red Raspberries.
Descriptions based on two weeks' old cultures grown on potato dextrose agar:—

Culture white raised mycelial in centre, with margin of black sclerotial formation: outer margin surface-loving mycelium; patches of tufted aerial mycelium 2 to 3 mm. tall; mycelium, hyaline, septate, surface-loving to aerial, $1\frac{3}{4}\mu$ - $3\frac{1}{4}\mu$ broad; conidiophores hyaline, 20 to 400μ long, non-septate to sparingly septate, simple or compound; branchlets 13 to 35μ long, single or in whorls of 2 to 5, tips slightly attenuated, bearing heads of conidia, hyaline, smooth, round, 6 to 30μ in diameter, with 12μ a fair average; chlamydospores spherical, single, or in simple or branched chains 4 - 10μ in diameter, average 6μ; conidia hyaline, oval to globoid, $2\frac{3}{4}$ - $6\frac{1}{4}$ by $1\frac{1}{4}$ - $4\frac{1}{4}\mu$. Sclerotia, black, cellular, knot-like, irregular, 30 to 60μ in length, single, or anastomising into large black masses; eventually forming sclerotial crust over surface of medium.

Fig. 9. *Verticillium ovatum* on peptone dextros[e] nitrate dextrose and potato dextro[se] agars, in order from left to right.

Control

Since this is a comparatively new diseas[e] very little is known as yet concerning defini[te] control measures; however, from our pr[e]sent knowledge of the fungus causing this di[s]ease, we would strongly advise as follows:-

(1) Set out healthy, certified stock th[at] has come from plantations free of this a[nd] other diseases.

(2) Since *Verticillium* sp. are also ca[pable] of infecting potato, tomato, peppers, a[nd] egg plant, causing wilt, do not set raspber[ry] plantings on soil that has just previous[ly] been planted to potatoes, tomatoes, peppe[rs] or egg plants (particularly if these cro[ps] showed any signs whatever of "wilting") b[e]cause these crops are subject to the same w[ilt] disease as raspberries and, therefore, [if] raspberries follow one of these crops, w[ilt] may be expected in the new setting. It h[as] been the experience of many growers th[at] under such conditions wilt very often beca[me] prevalent in the raspberry plantation. O[f] course, if the previous crop of potatoes, t[o]matoes, or egg plants was healthy, then [it] would be safe to follow with raspberries.

(3) Since the fungus is able to live ov[er] in the soil, practise a four or five ye[ar] crop rotation taking into consideration th[at] potatoes, tomatoes and egg plants are su[b]ject to this same disease.

(4) It is not advisable to plant potato[es], tomatoes, or egg plants between rows of ras[p]berries as "wilt" may be thus introduced.

(5) Since this is a soil disease it is hardly to be expected that either spraying or rogueing will be of any great value.

(6) Resistant or immune varieties will probably offer the best means of control.

Summary

1. In 1923 a disease of raspberries known as "Blue Stem" was reported. The causal organism was a species of Verticillium. The term "Blue Stem" has now been discarded in favor of "Wilt".

2. The following varieties in Ontario have been reported as affected—Cuthbert, St. Regis, Marlboro, Viking, and Herbert.

3. "Wilt" is first apparent as a yellowing, drooping, and casting of the leaves. The defoliation of the leaves is generally accompanied by a bluish discoloration of the cane, so that finally the diseased cane stands defoliated and is of a bluish color.

4. A species of *Verticillium*, a soil inhabiting fungus, was repeatedly isolated from diseased canes.

5. Inoculation tests carried out in the greenhouse by placing pieces of the *Verticillium* fungus in minute slits in healthy canes, proved the *Verticillium* fungus to be the cause of the "wilt" disease.

6. A study of *Verticillium (raspberry)* and *Verticillium Dahliae* Klebahn in culture on different media demonstrated that they were dissimilar.

7. *Verticillium (raspberry)* is also dissimilar to *Verticillium caulophagum*, the cause of "Blue Stem" of black raspberries.

8. The results of cultural studies of several forms from various hosts have shown that the *Verticillium* forms can be separated into two groups on the basis of their resting state, having sclerotia formation in one case and darkened mycelium in the other.

9. Since *Verticillium (raspberry)* is an unidentified species, the authors propose designating it *Verticillium ovatum*, referring to the shape of the spores. A description is given.

10. Suggestions for control are (1) use of healthy, certified stock, (2) crop rotation, and (3) avoid inter-planting of potato, tomato, egg plant, etc. between rows of raspberries.

11. These suggestions are largely based upon the fact that this same fungus, or one closely related, is also the cause of "wilt" on potatoes, egg plants, tomatoes, peppers and in Holland also of cherries. Cherry orchards there have been badly diseased due to throwing the refuse from diseased tomato crops in the cherry orchard.

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KNOW YOUR RED CLOVER SEED

The spring of 1926 again finds us confronted with a shortage of Canadian-grown clover seed. Whether such a condition occurs in two succeeding years, as it has in the years 1925 and 1926, or whether the seasons of shortage be separated by a number of years of plenty the danger accompanying the years of shortage is always the same. Our rigorous Canadian climate demands a hardiness in red clover plants not found in the plants of the majority of red clover-growing countries. As a consequence the seed from most foreign countries will not produce plants sufficiently hardy to produce paying crops of red clover in the greater part of Canada.

We have been informed on what we believe to be good authority that a considerable amount of seed from Southern European sources has already found its way into our Canadian markets for sale during the present season. A greater part of this seed very likely comes from Italy and France, and our tests extending over a period of years, with rec clovers from many different countries, have proven that Italian clover seed cannot be depended on to produce a paying crop even under the most favorable winter conditions About sixty per cent of the French red clove seed is equally non-hardy so that the chance are very great of clover failure with seed from either of these countries.

We would strongly recommend the pur chase of, first, Canadian-grown seed; second seed from the Northern United States o Northern European countries as Sweden third, the seed of English origin, and would recommend the substitution of some othe clovers in place of red clover rather than use seed from Southern Europe or even seed o unknown origin.

G. P. McRostie,

Dominion Agrostologist

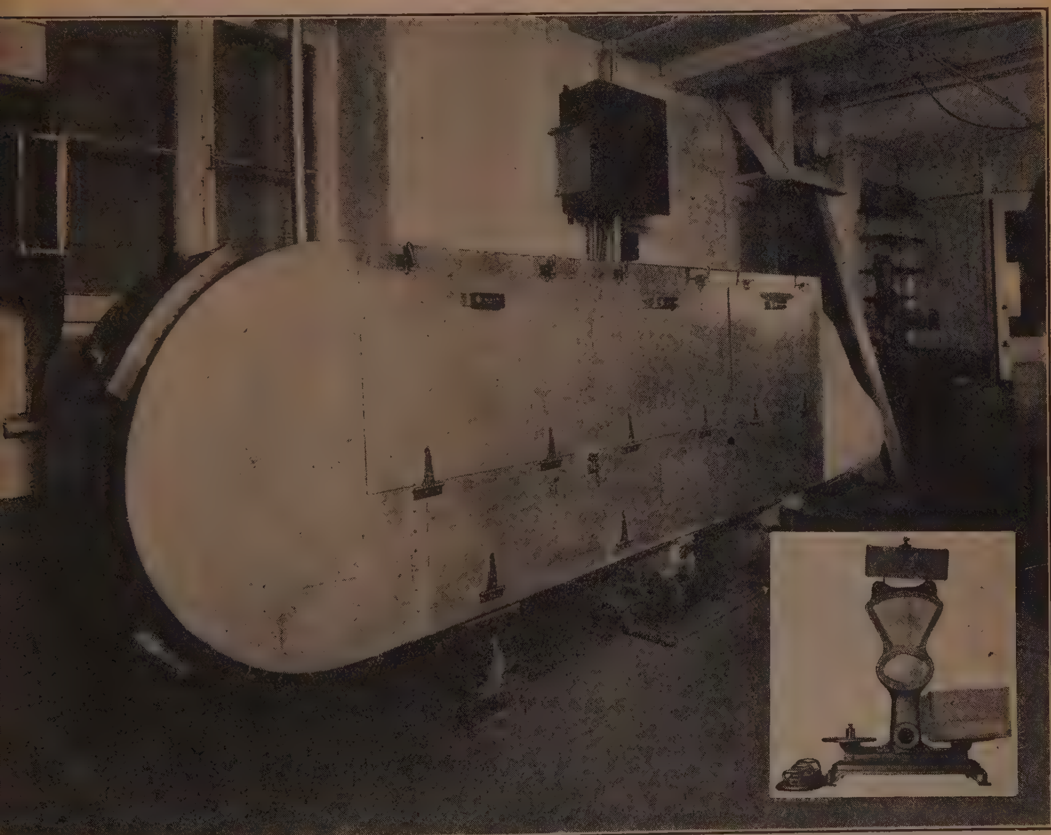
New Appliances for the Determination of Absolute Dry Matter.

G. P. McROSTIE and R. I. HAMILTON

Forage Crop Division, Central Experimental Farm, Ottawa

Comparative yields of fodder crops expressed in terms of the weights of such crops as harvested, are now quite generally considered to be inaccurate—if not grossly misleading. The same yields expressed in terms of field cured material are more accurate but still liable to be misleading because of the personal element which enters into this "Guessed Dry Weight". Various practices of partial or complete drying are followed by different colleges and experimental stations in an endeavour to get accurate comparable data. Of such practices the use of absolute dry weights is open to the least criticism on the grounds of possible inaccuracies. A very serious objection to the use of absolute dry weights as obtained by ordinary chemical methods exists however, in the limited numbers of samples that can be handled in a day with the equipment usually available.

The Division of Forage Plants at the Central Experimental Farm, Ottawa, Ont., has finally worked out, after a considerable amount of experimenting, a system of obtaining absolute dry weights that appears to be simple, accurate and speedy.



Complete equipment showing case, fan (covered) fan motor, control panel and scales for weighing moisture free material. (Inset) Scale for weighing dried sample. Graduated to 1/16 of an ounce and in actual practice readings are made to 1/32 of an ounce.

When a field plot is cut it is immediately weighed and then a large representative sample is extracted. This is conveyed to a cutting box, conveniently located under a large canvas at the scene of operation, and here cut in short lengths. The cut material is thoroughly mixed and duplicate two, five or ten pound samples, depending on the crop, weighed out with a scale graduated to one-sixteenth of an ounce. The whole operation from harvesting to sampling occupies a very short time so that loss from evaporation is reduced to a minimum. The samples are put temporarily into large manilla paper bags, which are conveyed to th drying trays at convenient intervals.

The drying trays are twenty-four inche long, eighteen inches wide and three inche deep, and have a fine copper wire cloth bot tom.

The cut shrinkage sample is spread out i these trays and then placed in large con taining racks, which accommodate eight trays. Sufficient space is allowed betwee the trays for a good circulation of air. Th racks are placed where the maximum of ai circulation will reach them, and under fav ourable conditions twenty-four hours is suf

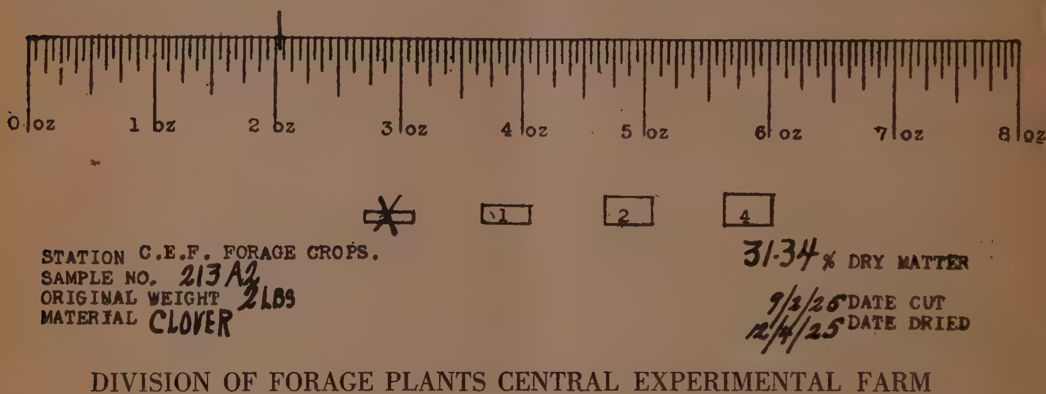
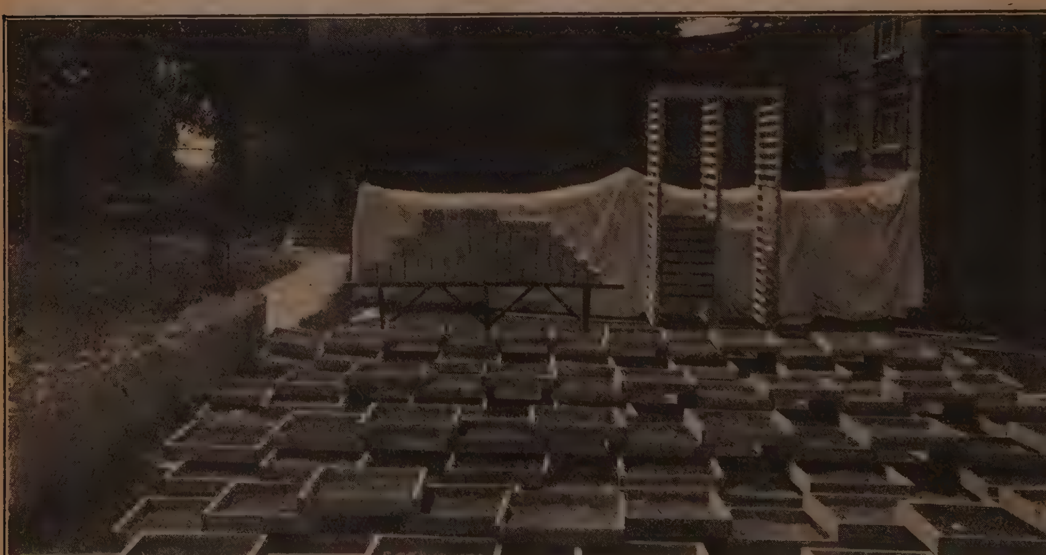


Chart label which remains with sample through complete operations. Graduated the same as chart on scale; the weight is recorded by a check mark where scale pointer comes to rest.



Bags for bringing shrinkage samples from the fields: trays for air drying: tray rack and cartons for storage or shipping air dry samples.

B. One door of drying compartment open showing trays in place.
C. Door of heating compartment open showing part of heating units.
D. Starting switch and electrical control panel.
E. Fan (covered) fan motor and thermostat dial.

ficient to dry samples of hay crops sufficiently for safe storage. The material when air dried can be stored in paper cartons until a convenient season for absolute dry matter determinations or, when opportunity permits, the latter determinations can be carried out without further storage.

For the determination of the absolute dry matter content, the air dry samples are placed in covered trays made from similar copper wire-cloth to that used in the tray bottoms and bound throughout with heavy tin. The trays are sufficiently large to accommodate the complete air dry material from either the two or five pound samples, or even from the ten pound samples taken in the case of field roots.

The drier is rectangular in shape with one rounded end, the walls are constructed from two layers of twenty gauge galvanized iron, two spaced inches apart. The two inch spaces are packed with mineral wool to increase the heat retaining capacity of the machine. The interior is divided longitudinally into two compartments by a one inch insulated partition, space being left at the rounded end for a free circulation of air between the upper and lower compartments. At the opposite end of the machine a sirocco fan is connected with the drier in such a manner that the air is drawn through the lower compartment of the drier and delivered through the upper compartment.

This upper compartment is much larger than the lower and is fitted on either side with a number of narrow iron strips which support the trays during the drying process. Fifty trays can be accommodated in the machine at one time. These are arranged in tiers ten trays long and five trays deep with a space left both between the tiers and at each end of the trays.

In the lower compartment are two batteries of 500 watt Westinghouse strip heaters which generate the heat required for the drying process. The temperature is regulated to a fine degree of accuracy by means of a thermostatic control illustrated in the accompanying cuts. All that is necessary is to set the hands of the regulating dial to the temperature or range of temperatures desired and the control system will do the rest.

At the rounded end of the drier are two doors, one at the top through which moisture laden air may be expelled and the other opposite the lower compartment through which fresh air may be drawn. These doors are arranged so that as much or as little air as desired may be changed in the drier.

The machine has been carefully checked against the ordinary laboratory methods of drying and has been proven accurate in its work. Whereas with stationary air quite a few hours drying are necessary to expel all of the moisture from the samples under test, where a heavy forced draft is used drying is accomplished in a remarkably short time. Practically all of the moisture is extracted from the ordinary air dried fodder samples in about one hour's time; however in our operations samples were left in the oven for two hours to allow a wide safety margin.

About two hundred samples constitute a fair day's drying with the machine in question; however during a rush period last December the machine was run continuously and five hundred samples every twenty-four hours were put through.

Two complete sets of trays are used with the machine so that one set of trays can be filled and labelled while the material in the duplicate set is being dried. This arrangement results in a minimum waste of time in refilling the machine and consequently increases the day's output.

For the final weighings a standard model of Dayton scale was used. The chart on this scale is graduated to one-sixteenth of an ounce and can be read accurately to the nearest thirty-second of an ounce. The pointer with its hair line for accurate reading comes to rest very quickly so that little time is lost in securing a reading.

Given a standard weight of the shrinkage sample as harvested, each division on the chart of the scale corresponds to a definite percent of dry matter in the sample being weighed. This relationship has been worked out separately in table form for two, five and ten pound shrinkage samples. All that is necessary is to record the weight as indicated by the scale pointer, then by reference to the portion of the table opposite the weight obtained read off the percent of dry matter in the sample concerned.

Extensive tables, which we hope to publish in the present year, are being prepared for translating various green weights at varying percentages into total tons and pounds per acre of both green and absolute dry material.

In three months time, with the apparatus described, over twenty thousand full sized shrinkage samples have been handled. With the exception of two weeks, during which time the machine was run continuously, all of the work in connection with the absolute dry matter determinations has been done by two men who besides their regular duties have had time to do various odds and ends of related work.

The results have been highly gratifying and we trust that our experience in this connection may be of some benefit to our co-workers who may be confronted with similar problems.

Crank Case Dilution in Kerosene Burning Tractors.*

L. G. HEIMPEL

Professor of Agricultural Engineering, Macdonald College, P.Q.

Ever since the development of the internal ombustion engine employing some form of rculating system for the lubrication of the ylinders and the various bearings enclosed the crank-case, dilution of the lubricating il by the fuel used has added much to the oubles of the user, the manufacturer and e engineer. In the early days of the autoobile industry, when gasolines had a gravy of 72 and 74 Baume, there were, of ourse, no such troubles. The oil used in the rank-cases of engines prior to 1913 was ften of a consistency similar to that of cream parator oil, or what was called "dynamo" fine "engine" oil, yet the lubrication was lendid and engine wear comparatively ght. With fuels of such high volatility dilu-on of the lubrication oil was hardly pos-ble.

With the tremendous expansion of the autoobile industry, however, the available suply of light or "high test" fuels soon disapeared and the oil companies were forced to corporate into the gasoline petroleum disllates of higher end points to provide a sufcient supply.

The great war aggravated what, in this resect, already was a serious situation. Everyone quainted with the nature of the gasoline ld from 1917 to the present time can testi- to the lack of volatility as indicated by diffilt starting in cold weather, and the necesty for frequent changes in cylinder oil.

It is interesting to note what has hapned to the end point temperatures of the disllates sold as gasoline from 1915 to 1921. ccording to figures from the United States ureau of Mines, the average gasoline sample 1915 had an end point of about 345 derees F.; in 1917 this point had advanced about 385 degrees F., in April 1919 to out 420 degrees F., and in January 1920 to out 430 degrees F., where it has remained a general way since. It is the nature of e fuel used since 1917 which is to blame r the more serious dilution of lubrication ls in the automobile engine, and in no way is the magnitude of these troubles more strikingly illustrated than in the following quotation from a paper on this subject by W. F. Parish, an eminent lubrication engineer, in 1923, in which he says, in part, the following:—

"The consumption of pistons, piston bushings and piston rings increased 1480 per cent from 1914 to 1923, and that of piston pins 1380 percent. Registration of new cars over the same period increased only 700 per cent or about one-half that of the worn-out and replaced parts.

The value of replacement parts has increased from $11,000,000 in 1914 to $198,000,000 in 1923; this is an increase of 1800 per cent. When we add the cost of service labor, the public charge is approximately $450,000,000.

These figures do not take into consideration replacement parts for used cars, which are repaired by factory dealers or factory service stations. About 2,000,000 cars per year are so handled. This would add another $50,000,000 to the cost of poor lubrication due to dilution".

The damage due to increased dilution of the crank-case oil, as less volatile fuels had to be utilized, in the face of these figures, can hardly be doubted. But we must remember that these are based on experiences with engines using gasoline, and, if this is so, how much greater must be the rate of dilution and how much greater the damage when kerosene is used as fuel in these engines.

Kerosene has for quite a few years been advocated by some stationary engine and tractor manufacturers as a fuel for their engines, or perhaps we should say the public has demanded that engines be equipped to burn kerosene. The writer used it as early as 1912 in large tractors on the Canadian prairie. The engines in which its use was most suc-

*A paper read before the Convention of The American Society of Agricultural Engineers (North Atlantic Section) at Schenectady, Dec. 11, 1925.

cessful were, however, of the fresh oil type, such as the old Hart Parr, the Rumely, the Pioneer and later, the Mogul and Titan engines of the International Harvester Company. Many of the first mentioned makes of machines, while they were exceedingly heavy and clumsy, leaving much to be desired as tractors, showed tremendous length of life so far as the power plant is concerned and it is very likely that the fresh oil lubrication system is to be thanked for this.

Of late years those of us who have had opportunities to observe the performance of some of the later types of multi-cylinder engines have, no doubt, seen plenty of cases indicating serious dilution when these engines were run with kerosene as fuel. One case in particular remains very clear in the writer's recollection. This machine, for no apparent reason, refused to drive a thresher which, up to a few days previously, had not been a serious load. The oil gauge showed that the crank-case was almost full; after a few hours of attempted threshing during which the engine laboured badly, it was noticed that the oil indicator had risen perceptibly. Upon enquiry of the owner it was found that no new oil had been added for two days and that the gauge showed a little over half full when the last fresh oil had been added. The dilution in this particular case was easily more than 50 per cent. Experiences such as the above and a knowledge of the increase of crank-case oil dilution in automobile engines prompted the undertaking of the experiments which we will attempt to outline here.

It would be possible under laboratory conditions to run a tractor under load for given lengths of time and to take samples of the oil at intervals from which the amount of dilution could be determined. This would, however, give us conditions as they exist with one engine only. It was decided, therefore, to secure the co-operation of tractor-owning farmers of which there are several in the vicinity of Macdonald College. The instructions were that samples should be taken at five hour intervals up to 40 hours, if possible, and no new oil should be added while samples were being taken. Adding of oil when necessary was taken care of by removing all the oil after 15 or 20 hours of work and starting again with new oil in the crank-case. When after fifteen or twenty hours more work more oil was needed some of the 15 or 20 hour oil previously removed was added. Samples were secured in this way from four tractors and the work done by them during the tests consisted of both draw bar and belt work. The oil used consisted in three cases of Imperial Kerosene Tractor oil and in one case of Mobile B.

The percentage of dilution was secured by distillation under atmospheric pressure, using 100 cc. samples in 250 cc. Engler distillation flasks, the flasks having previously been encased in a jacket of a magnesium and asbestos mixture. To ascertain the amount of light distillate to be expected from the oils used, samples of clear oil were distilled and the amount coming over before the approximate end point of commercial kerosene was reached was recorded and deducted from all diluted samples distilled later.

The end points of the fuel used were arrived at by the addition of a given amount of fuel, usually 10 cc., to 90 cc., of the previously distilled new oil and the temperature at which the 10 cc. of fuel came off was taken as the end point of the fuel in question. The end point of the gasoline used was found to be about 432 degrees F. and that of the kerosene was found to be 547 degrees F.

From two of the engines two sets of samples were secured, one with kerosene and one with gasoline as the fuel. A great deal of work has already been done with the latter fuel, so that one or two check samples were thought sufficient for our purposes.

Engine No. 1 was a Fordson tractor in which compression was poor owing to badly worn rings. The tests were run off during the months of September and October, but there were no exceptionally cool days during the run. The needle valve was kept adjusted to a moderately lean mixture at all times. The dilution in this first engine was, however, excessively high, running as follows:—

5	hours	—	17 %
10	"	—	26 %
15	"	—	24 %
20	"	—	38.5%

Burning gasoline this engine showed the follownig rate of dilution:—

5	hours	—	3 %
10	"	—	4 %
15	"	—	5½%
20	"	—	6½%

No. 2 engine was also a Fordson which owed the following rate of dilution when sing kerosene:—

5 hours		—	5.25%
10	"	—	10.5 %
15	"	—	13.5 %
20	"	—	16.5 %
25	"	—	21.0 %
30	"	—	15.5 %
35	"	—	17.0 %
40	"	—	18.0 %

On gasoline the dilution was as follows:—

5 hours		—	4.5 %
10	"	—	5.0 %
15	"	—	4.5 %
20	"	—	7.75%
25	"	—	6.25%
30	"	—	10.5 %
35	"	—	11.5 %
40	"	—	8.0 %

This engine was in splendid mechanical ondition and was in the hands of a good perator.

The small percentage of dilution when asoline was used as fuel is worthy of note. his is less than is generally found to be the ase in automobiles, and is no doubt due to e fact that the tractor is always subjected a heavier and more uniform load than the utomobile engine, thus maintaining a higher ngine temperature, lessening dilution.

No. 3 engine was a new machine, McCorick Deering 10-20. Only one set of samples as secured from this machine and this with erosene as the fuel. Dilution was as folws:—

5 hours		—	3.75%
10	"	—	8.0 %
15	"	—	13.5 %
20	"	—	20.0 %
25	"	—	24.0 %
30	"	—	27.0 %
35	"	—	30.5 %
40	"	—	32.5 %

No. 4 engine was another Fordson. The ork done during the test was largely belt ork of a more or less intermittent nature, hich would account for some of the excesve dilution noticed in this set of samples. he rate of dilution was as follows:—

5 hours		—	15%
10	"	—	54%
15	"	—	61%
20	"	—	67%
25	"	—	26%

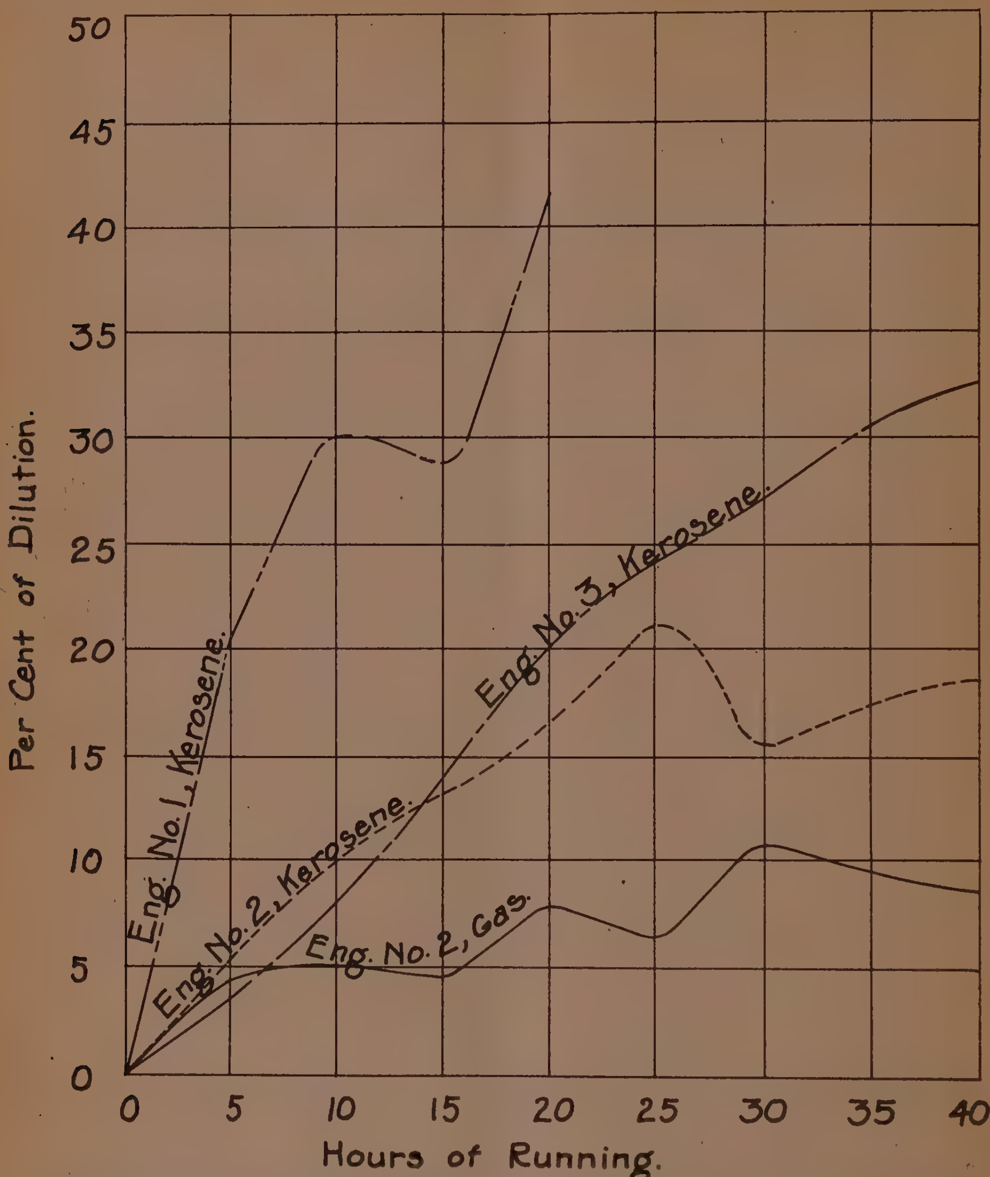
After distilling these samples the engine was examined in an effort to locate the cause of such tremendous dilution. It was found to be due to the use of an excessively rich mixture. The policy of the operator seemed to be to leave the needle valve alone, the result being an overly rich mixture increasing dilution.

The discrepancy in the percentage of dilution between the 20 and 25 hour samples can be due only to some mishap in the taking of the sample and should, we believe, be disregarded. The excessive dilution occurring in this series of samples can be due only to a combination of all the forces having a tendency to cause it, namely,—poor compression, rich mixture, cool weather and an intermittent load. All of these existed in connection with this tractor during the test run.

Reviewing these results we find that the highest percentage of dilution where gasoline was used as fuel was 11.5% in engine No. 2, this in 35 hrs. Engine No. 1 showed 6½% in 20 hours. On the other hand, the dilution present in engine No. 2 was 21% in 25 hours when kerosene was used as a fuel, 38.5% in 20 hours in engine No. 1, 32.5 in 40 hours in engine No. 3 and 67% in 20 hours in engine No. 4.

The next question is, How much dilution can an oil absorb without definite damage to its lubricating qualities? The answer to this is to be found in work done by Stratford and Parish in their investigations of this subject in connection with automobile engines. Their findings are to the effect that when an oil becomes thinned to the point where it has a viscosity of 180 Saybolt seconds at a temperature of 100 degrees F. its lubrication qualities are seriously affected. Stratford calls this point the critical point in the viscosity of a gas engine cylinder oil.

An extra heavy oil has a viscosity of about 550 Saybolt seconds at 100 degrees F. and when diluted with 16 percent of fuel its viscosity will be lowered to the critical point mentioned above. Light motor oil requires only 2% of dilution to make it too thin for effective lubrication in gas engines. In two of the tractors from which we distilled oil samples an extra heavy oil would be thinned down to the 180 Saybolt seconds at 100 degrees F. in from five to six hours of operation. In the case of the two engines giving lowest rates of dilution the critical

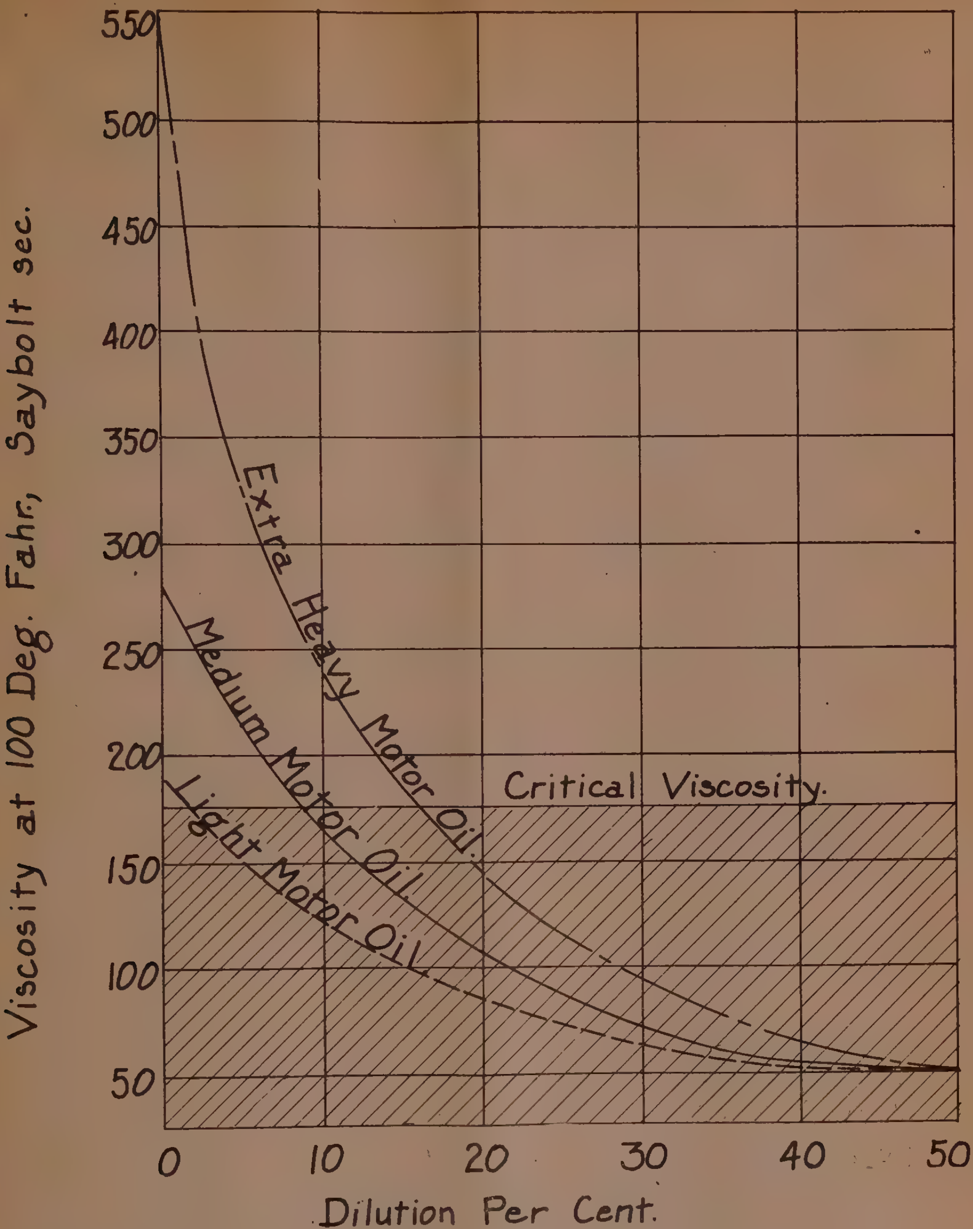


Graph showing rate of dilution of three of the engines during the tests. Note the small amount of dilution in Engine No. 2 when gasoline was used.

point in the condition of the oil was reached after 15 or 20 hours of operation.

The above results seem to indicate very clearly that a close relationship exists between the mechanical condition of the engine and the rate of dilution. Engine No. 1, for instance, had very poor compression, hence a much heavier fuel consumption accompanied by heavy dilution. Engine No. 2 was of the same make, but in good condition and the percentage dilution was much smaller. In all these engines, however, the dilution resulting from the burning of kerosene is much heavier than any oil can bear and still maintain its lubricating value. Not many tractor users change oil more frequently than once in forty hours of operation. It is therefore safe to assume that about half of the time the average kerosene burning tractor is at work, it is suffering from lack of proper lubrication.

In conclusion it is difficult to point to any easy way out of this problem. The farmer wants cheap fuel and so long as there is a



This chart shows the amount of dilution an oil can carry before its lubricating powers are unimpaired.

difference of five cents a gallon or more between the cost of gasoline and that of kerosene many will prefer to buy the latter. In the light of the above findings, however, it would seem desirable to advise against the use of kerosene in any but "fresh oil" types of engines. Changing the oil every 20 hours would, of course, be sufficient to ensure reasonably good lubrication, but is very expensive and exceedingly wasteful of oil unless some simple, effective and inexpensive method of reclaiming the oil is developed. The future offers, if anything, less light and more heavy fuels so that the use of heavy fuels must be provided for. Whether this will mean a return to the fresh oil system of lubrication, or a radical change in the type of tractor engine is required, is the problem confronting the designer, the engineer and the manufacturer.

ACKNOWLEDGEMENTS

The writer is greatly indebted to the assistance of Mr. C. M. Baskin of the Imperial Oil Company, Montreal, Canada, for his advice in connection with this work; also to William F. Parish whose previous work on crank case dilution in connection with automobile engines was of great value. L.G.H.

A Quarter Century of Herd Improvement.

HERBERT GROH

Botanical Division, Central Experimental Farm, Ottawa

When the writer's father, more than twenty-five years ago, turned definitely to dairying as the mainstay of his farming operations, his first step in this direction was the purchase of a pure-bred bull from one of the early pioneers among Canadian Holstein breeders. This first bull was followed, as necessity required, by others of the same breed, each supposedly a little better bred than the last, but none, even in recent years, that anyone would call high-priced. The herd has remained strictly a producing farm herd.

At the same time that better breeding began thus to receive attention, a beginning was also made in weeding out inferior cows. It was out of the question financially then to replace the existing herd with pure-breds, although two purebred heifers were acquired soon. With these early and lone exceptions, new blood has been introduced only through the sires; and herd improvement otherwise has depended entirely on judicious retention of the good, and elimination of the poor females. Improvement of production has of course, been helped as well, by the third of the factors usually emphasized, namely better feeding.

As the necessary means of carrying out intelligently such a program of selection and weeding, the keeping of milk records was commenced on the first of January, 1899. The completion recently of a full and uninterrupted quarter century of these records, should make some review of the period therefore opportune. A sketch of the herd, reminiscent of its history and management, was published some time ago. (Farmer's Advocate, London and Winnipeg, Christmas Number, 1922). A fair start had also been made upon analytical studies of the 337 lactations recorded, when other work interfered; and the chart presented herewith is merely one of these studies designed to show at a glance the results which attended the pursuit of the policies outlined above.

It should be explained that daily individual weights of milk were recorded for all cows for the whole time that each remained in the herd. Butter-fat, feed, and other records were kept, but with less regularity. Breeding records are almost complete, and it may be mentioned in passing that four of the eight foundation cows are still, after all these years, represented by progeny in the herd.

It is neither feasible nor necessary to present in detail here, all the milk records, or even their monthly or yearly totals. In the chart each of the dots, one hundred in number, represents the first lactation record of a heifer, and is placed under the year in which she freshened. This convenient number happens to include all heifers except a few that milked for only a small part of a lactation. Each dot furthermore is placed in vertical position to indicate the milk yield in the first eight months of the heifer's production, eight months being adopted as generally a more reliable period than either a short-term record, or a full lactation, which is affected by irregularities of breeding, etc. The first lactation may, or it may not be better than a later one, as the gauge of a cow's performance, but it is used here without option, as the only one possessed alike by all these animals.

It is readily to be seen from the position of the dots, and from the general course of the erratic line which joins their averages for each year, as well as from the straight line which smooths out these averages, that milk yields tended upward. Progress was by no means uniform from first to last, but the widest departures from normal improvement, in years like 1903, 1904, 1913, 1914 and 1915, are chiefly attributable to chance groupings in one year of a few good or a few poor records. The extremely poor showing of quite a number of the 1914 heifers was due to underdevelopment from known causes such as are not always avoidable; but might be accounted for partly too, by less severe selection at a time when the herd was being increased in numbers as quickly as possible.

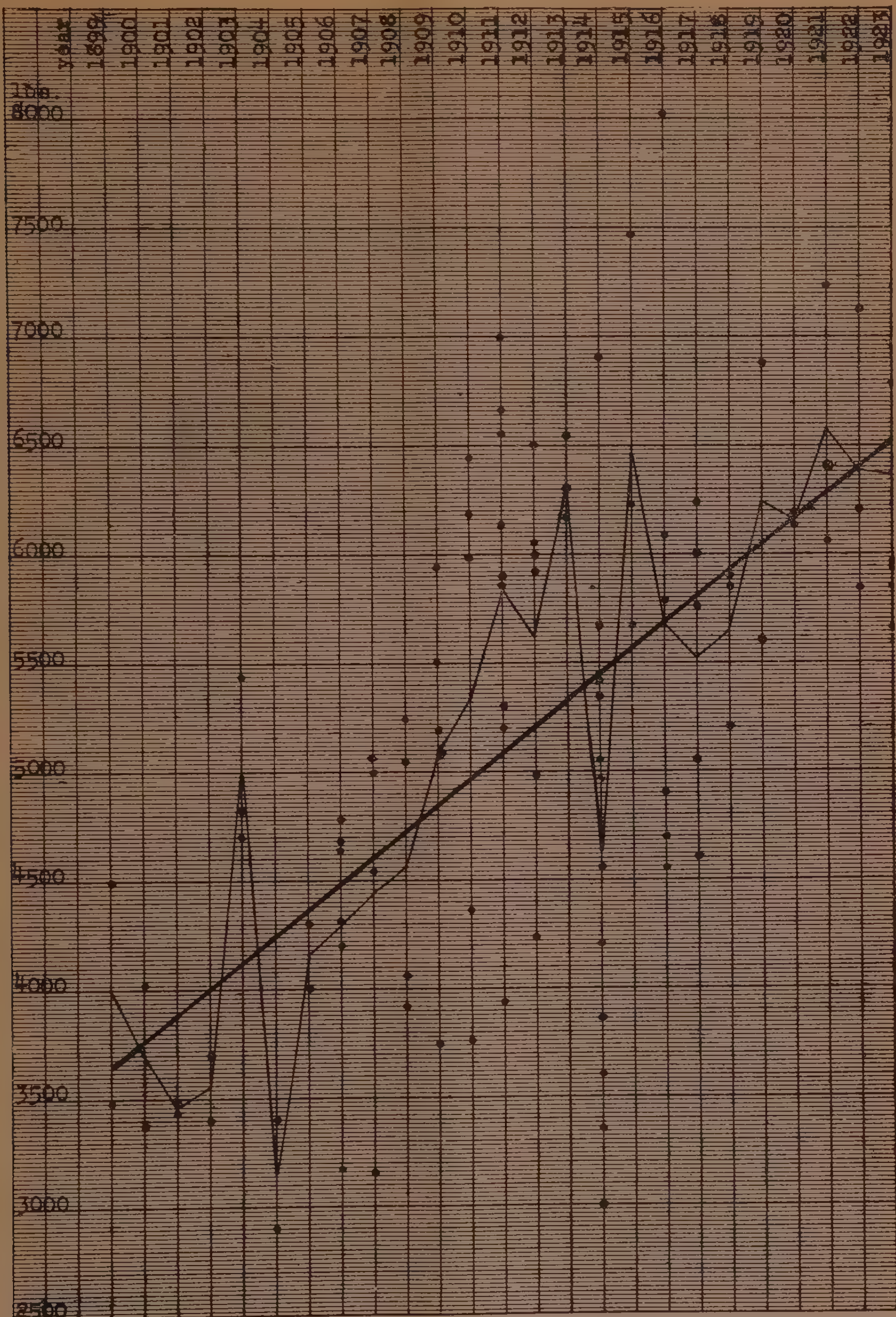


Chart of eight-month milk records in first lactations of 100 heifers freshening in the herd of Anson Groh, Preston, Ontario, from 1899 to 1923, inclusive.

It is to be noticed that the trend upward is maintained fairly well to the end, as it should be in a herd still far from the limits of possibilities in breeding and crowding for production. None of these cows has ever been under official test. Only a few of the heaviest producers were ever forced in any unusual degree, although naturally and pro-

perly, exceptional cows as a rule received extra attention. This would have but little influence though, on the first lactation records shown in the chart, which were made on a reasonably equal footing, apart from the matter of age and development at freshening.

In appraising the value to the herd of each individual charted, it is considered that her actual record is of much less consequence than her position relative to the rising line of average production. The best cow in this relative sense is the one most above the average of her time, whenever that may have been. As a breeder she is the one we must look to (provided she can transmit her good qualities) for the higher yields of the next generation. As it happens, the highest absolute record here, (in 1916), is also the highest relatively; but some records below the average in the former sense, are very much above it taking into account when they were made. Thus the record of 4500 pounds made in 1899 was worth much more than that of 4600 pounds in 1917, or even the highest in the latter year. Something like an arrangemen in order of merit could be made, starting with the record of 8024 (for eight months) at the top, and proceeding, according to departure from the average line, above and below, to the record of 3007 at the bottom.

It was not necessary though, to base an estimate of most of these cows on only one year's work. By omitting those without a second lactation, a similar chart was prepared based on averages of the yields in the first two lactations; and so also again for as many lactations as were well represented with cows. While most cows proved to have got into nearly their normal stride from the first, there were still some whose later records greatly altered their early promise. At least three of the heaviest mature producers of their time, were considerably below the average line of the first lactation chart—which goes to show the value of continued testing, supplemented always by a liberal allowance for conditions that may have influenced the yield. No utter dependence on milk records, however useful they be, can ever take the place of the "master's eye".

The use of milk instead of fat production data in this study, is defended partly on the ground that the herd was run mainly for town milk trade, but chiefly because butter-fat records are not available for all the cows. Charted in a similar way for the cows whose tests are known, the fat production records show clearly the importance of this basis of evaluation. As a general rule, exceptionally high milk yield went with somewhat low fat test; while a cow below average for milk yield sometimes proved after all to be a distinct asset to the herd as regards maintaining the required general test.

MALTING BARLEY IN DEMAND

There is a demand for malting barley. For many years, reports the Dominion Cerealist, the growing of barley for malting has been neglected until now Canadian malsters find it difficult to obtain sufficient quantities. A certain malting company has been taking special interest in the matter and has tested a large number of barleys from different localities. Each sample was tested for moisture, albumen, germination, steeping and mealiness and put through a regular process of malting. The company states that two-rowed barley, under certain conditions, has been found to degenerate into barleys containing abnormally high albumen, while under the same conditions six-rowed types develop normally in respect to albumen content. It is thought this statement would not apply to districts where two-rowed barleys thrive better than the six-rowed. Two-rowed are more commonly grown under Maritime conditions whereas the six-rowed varieties are more strictly continental. For inland conditions the company recommends the Manchurian type, which includes O.A.C. No. 21 and Manchurian Ottawa 50.

Barley from New Ontario is favourably commented upon while that from southern Manitoba, northern Alberta and eastern Saskatchewan has proven most satisfactory to date.

The main requisites of a good malting barley, the Dominion Cerealist in his annual report for 1924 points out, are purity of variety in order to ensure evenness of germination in the making of malt and good general condition of the grain itself.

Soil Treatment with Various Disinfectants.
Preliminary Report

T. G. MAJOR

Tobacco Division, Central Experimental Farm, Ottawa

INTRODUCTION

During the season of 1925 tests were carried out on the relative value of a number of commercial chemical preparations as tobacco seedbed soil disinfectants. These were of two types, the first having some form of organic mercury as the active principle, and the second, formaldehyde. In the first group were included Germisan (Fahlberg, List & Co.), Uspulun, Bayer Compound, Bayer Dust, (Bayer Co. Inc.) and Semesan, Dust No. 12, Dust No. 13, (Dupont de Nemours & Co.), and in the second group, Kalimat and Super-Kalimat (Chicago Process Co.)

The experiments were conducted at the Central Experimental Farm, Ottawa, using ordinary glass-covered seedbeds of the semi-hotbed type. As the weather was warm most of the time it was found unnecessary to keep the sashes on except during the first week after sowing the seed. The soil was made up of a manure and sod compost to which was added field soil known to be badly infested with the black root-rot fungus, *Thie-*

TABLE 1.

No.	Preparation	Quantity per sq. yd.	Time of germin ation	Tobacco plants per sq. ft.	Weeds per sq. ft.	Thielavia infection	Size of largest leaf
1.	Checks—Water	1 gal.	5–7 days	404	36.2	40%	100%
2.	Germisan—0.25%	½ "	7 "	228	25.0	50%	89%
3.	"	2 "	12 "	126	0.2	0%	32%
4.	Uspulun—0.25%	½ "	7 "	322	36.0	10%	75%
5.	"	2 "	9 "	172	12.0	0%	58%
6.	Bayer Comp. 0.25%	½ "	8 "	364	27.0	0%	109%
7.	"	2 "	8 "	328	4.0	0%	62%
8.	Semesan—0.25%	½ "	7 "	450	15.0	60%	65%
9.	"	2 "	8 "	410	13.0	20%	50%
10.	Kalimat—0.25%	3 "	5 "	326	24.0	0%	131%
11.	"	5 "	6 "	296	36.0	0%	158%
12.	Formalin—2%	4½ "	6 "	254	8.0	0%	167%
13.	Checks—untreated	—	6–9 days	250	48.5	60%	100%
14.	Bayer Dust	¼ lb.	10 "	*—	*—	0%	75%
15.	"	½ "	11 "	*—	*—	0%	47%
16.	"	1 "	12 "	92	5.0	0%	20%
17.	"	2 "	12 "	74	3.5	0%	21%
18.	Dupont Dust No. 12	¼ "	11 "	*—	*—	0%	37%
19.	"	½ "	——	*—	*—	——	——
20.	"	1 "	13 "	22	0.7	0%	25%
21.	"	2 "	——	—	—	——	——
22.	Dupont Dust No. 13	¼ "	7 "	*—	*—	0%	47%
23.	"	½ "	8 "	*—	*—	0%	48%
24.	"	1 "	9 "	262	5.0	0%	52%
25.	"	2 "	11 "	82	1.3	0%	28%

* These sections were grown at a later date than the others and, owing to the writer's absence, no data were taken on these points.

lavia basicola Zopf. All sections were sown with seed of the Connecticut Havana No. 38 variety at the rate of 1/8 oz. per 100 sq. ft. This seed gave a germination test of 82%. Two experiments were carried out; in the first the rate of application, and, in the second, the strength of solution was varied.

I. Different Rates of Application

PLAN—In this experiment 0.25% solutions of the liquid treatments were applied at the rate of ½ gal. and 2 gal. per square yard, except in the case of Kalimat, where 3 and 5 gal. were used. The dusts were applied at the rates of ¼ lb., ½ lb., 1 lb., and 2 lb. per square yard. Ten sections were left as checks, to five of which water was added at the rate of 1 gal. per sq. yard, and the remainder were untreated. In addition, one section was treated with a 2% solution of commercial formalin at the rate of 4½ gal. per square yard. This is a standard seedbed treatment recommended by the Tobacco Division. All sections were aired for one week before sowing the seed.

SUMMARY OF RESULTS.—Data were taken on the following points: time of germination, number of tobacco plants per square foot, number of weeds per square foot, percentage of plants infected by *Thielavia*, and avera size of the largest leaf on each plant. The last measurements were adopted as criter of vigour of growth in preference to heig of stalk owing to the difficulty of measurin the height of very small seedlings. Prelim inary measurements with larger seedlin showed a close correlation between the tw characters.

The results are shown in Table I. F purposes of ready comparison the data c size of leaves are given as percentages of th checks. In numbers 1—12, 100% equals th average of the five checks treated with wat and in 13—25, the average of the five u treated checks. In sections Number 19 an 21 no germination could be detected. Th sample of Super-Kalimat was not received i time for inclusion in this experiment.

II. Variation in Strength of Solution

PLAN—In this experiment 0.25%, 0.1% and 0.05% solutions of each of the liqui treatments were applied at the rate of 2 ga per square yard. Seven check sections we treated each with 2 gal. of water, and, in a dition, two sections were treated with 2% formalin at the rate of 4½ gal. per squa yard. As in the previous experiment th

TABLE 2.

No.	Preparation	Quantity per Sq. Yd.	Strength of solution	Time of Germin-ation	Thielavia infection	Size of largest leaf
1.	Checks—Water	2 gal.	——	5–7 days	65%	100%
2.	Germisan	"	0.25%	7 "	0%	78%
3.	"	"	0.1%	6 "	10%	120%
4.	"	"	0.05%	6 "	20%	129%
5	Uspulun	"	0.25%	8 "	0%	48%
6.	"	"	0.1%	7 "	5%	64%
7.	"	"	0.05%	6 "	10%	97%
8.	Bayer Compound	"	0.25%	7 "	0%	87%
9.	"	"	0.1%	6 "	0%	102%
10.	"	"	0.05%	6 "	5%	123%
11.	Semesan	"	0.25%	8 "	15%	39%
12.	"	"	0.1%	7 "	20%	43%
13.	"	"	0.05%	6 "	20%	61%
14.	Kalimat	"	0.25%	5 "	0%	79%
15.	"	"	0.1%	5 "	15%	93%
16.	"	"	0.05%	5 "	35%	68%
17.	Super-Kalimat	"	0.25%	6 "	0%	102%
18.	"	"	0.1%	5 "	0%	115%
19.	"	"	0.05%	5 "	5%	117%
20.	Formalin	4½ gal.	2.0 %	6 "	0%	155%

sections were aired for a week before sowing the seed.

SUMMARY OF RESULTS—Owing to the writer's absence it was possible to secure data only on the time of germination, percentage of Thielavia-infected plants, and average length of the largest leaf. The summarized results are given in Table II. The comparative leaf sizes are again given in percentages, 100% being equal to the average of the seven checks.

Conclusions

Definite conclusions as to the relative value of the different preparations, and the proper concentrations and rates of application, cannot be drawn at the present stage of the investigation. There are, however, a number of points which seem to be fairly well established. The dust treatment of the soil is of no value by reason of the poor stand and reduced size of plant, as indicated by leaf size, although the disease is completely controlled. With regard to the liquid treatments the formaldehyde preparations do not appear to injure the plants as much as do the mercuric compounds. This is offset in the case of Kalimat, by the rather high percentage of Thielavia-infection. Of the mercuric preparations, Semesan gave the least satisfactory results, since, although the stand was good, the amount of disease was somewhat high and the plants were considerably reduced in size. From the point of view of weed control, the data show that none of the preparations will inhibit the growth of weeds unless applied in such a high concentration that the tobacco plants are also injured.

SUMMARY

1. Comparative tests were made of a number of organic mercury and formaldehyde preparations as tobacco seedbed soil disinfectants.
2. The preparations included Germisan, Uspulun, Bayer Compound, Semesan, Kalimat, Super-Kalimat, Bayer Dust, and Dupont Dusts Nos. 12 and 13.
3. The dust treatments control the black root-rot disease, (*Thielavia basicola* Zopf), but injure the germination and stand, and reduce the size of the plants.
4. The formaldehyde preparations do not appear to injure the host plants to the same extent as do the organic mercury compounds.
5. Data taken on weed control show that none of the preparations will check the development of weeds without also injuring the tobacco.

THE CLEANING OF SEED GRAIN

The objects of cleaning seed grain are (1) to remove other kinds of grain, weed seeds, dirt, chaff, pieces of straw, and other foreign matters and, (2) to remove all small, shrunken and broken seed, leaving only the very best of the kind of seed cleaned.

It has been observed at the Dominion Experimental Station, Kapuskasing, Ontario, that large,, plump, well matured seed germinates more evenly and gives a more uniform and higher yielding crop than seed of inferior quality. This is particularly true if early sowing, which is very essential in this section of the province, is practiced.

A good fanning mill if properly equipped with riddles and screens, and with a suitable control over the air blast, may give very good servic in the cleaning of seed grain.

It is rather difficult to give definite instructions for equipping and operating a mill which would be applicable in all cases, as both the grain and the mills may vary considerably. It may be pointed out, however, that each part of the mill should have a share in the cleaning process if best results are to be obtained. The air blast should remove all light material; the riddle or top sieve should remove the large sized impurities, and waste matter while the lower sieve should remove the small impurities, as well as the smaller seeds of the kind being cleaned.

Rapid cleaning should be avoided as this is very liable to prevent the sieves from functioning as they should.

Old mills often may be properly equipped with new screens by submitting samples of the seed to be cleaned to the manufacturer, and asking him to furnish suitable sieves.

La Revue Agronomique Canadienne

RÉDACTEUR—H. M. NAGANT

Les Caractères Héréditaires.

Leur nature, leur valeur

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1—Le problème qui se pose

Le but de cet article n'est pas d'exposer ex professo le "comportement économique", de nos fermes canadiennes, celles de Québec en particulier. Il parait cependant clair, même pour qui n'a pas le profil d'un comptable agricole, que nos cultivateurs canadiens, les prenant tels qu'ils sont, ne semblent pas précisément d'impeccables modèles; ils sont bien loin de tirer de leurs terres un rendement maximum. Il y a défauts et gaspillages à peu près dans toutes les branches.

Ceux qui font la campagne en faveur des engrais chimiques, de l'hygiène, de l'alimentation, et des autres nécessités actuelles, savent tout ce qu'il y à faire, à refaire ce qui est plus difficile encore. Et l'on se plaint, comme de raison que la vie sur la terre ne paie pas!

Dès qu'un problème surgit, réclamant une solution, surgit aussi l'obligation, grave en proportion de la gravité de la difficulté à résoudre, pour toute intelligence qui est en mesure de s'y appliquer, de travailler à sa solution. Le problème de l'amélioration, au Canada, de l'agriculture est d'une importance vitale et ne peut pas attendre. Les forces et les inerties qui entraînent notre population agricole vers le cosmopolitanisme canadien ou américain sont trop nombreuses, pour que nos terres ne soient pas désertées, si elles ne deviennent au plus tôt payantes et très payantes.

Il faut de toute nécessité inculquer ces principes et forcer à la pratique de tous ces moyens, aptes à rendre l'agriculture rémunératrice;—*moyens négatifs*: boucher les trous; faire voir le gaspillage, ses conséquences e son remède; enrayer les causes de déficit;— *moyens positifs*: implanter tous les facteur permanents, anciens et nouveaux, d'une pro duction plus grande, meilleure.

Voilà qui est d'urgence pour nous, Can adiens.

2—Un conseil en passant

Ici, laissez-moi vous placer une sourdine Dans notre position, il nous est défendu d mépriser aucune source d'amélioration, fu elle nouvelle, petite dans notre estime. Com ment contester, au reste, le droit de naître des méthodes qui ne demandent qu'à prouve leur efficacité. Nous sommes si loin d'avoi de la Nature et de ses mille forces une vu complète, claire; plus éloignés encore somme nous de saisir le rapport harmonieux de leu interactions. Nous ignorons encore probabl ment plus que nous ne connaissons. A caus de cette ignorance il convient que nous soy ons circonspects; à cause de ce que nous sav ons et de ce qu'il nous reste à apprendre, est de notre devoir d'être scientifiquement tr curieux.

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*Nous attirons spécialement l'attention des le teurs de la Revue agronomique sur l'article fond, de ce mois, qui parait sous la signature R. P. Louis-Marie, professeur de Botanique et Génétique à l'Institut Agricole d'Oka. Il constit la première partie d'un exposé des "caractères hé ditaires" chapitre des plus importants de la géné que, cette science d'introduction relativement cente dans l'enseignement agricole. Aussi la lectu de ce travail se recommande-t-elle à tous les agro omes qui veulent se tenir au niveau des dévelop ments de la science agricole.

N.D.L.

3—Nature des caractères, leur valeur

En botanique systématique, nous groupons les plantes dans des cadres que nous appelons: formes, variétés, espèces, genres, familles, ordres, classes..., grâce à certains écarts de formes ou de fonctions, appelés caractères morphologiques ou physiologiques. Ces caractères sont constitués en hiérarchies; le critère de notre estime à leur égard est leur amplitude et leur "stabilité".

Les zoologistes traitent semblablement le règne animal; ils font de plus entrer en scène les caractères psychologiques. Qui n'a pas rencontré des chevaux vicieux et différemment vicieux? Ces derniers caractères ont plus d'importance encore en anthropologie.

Maintenant si nous portons notre attention sur ces seuls êtres vivants que l'agriculture a faits siens par domestication—végétaux et animaux—nous verrons qu'à côté de quelques grands traits génériques ou spécifiques, à côté des airs de familles (airs des Graminées, des Crucifères, des Rosacées, des Légumineuses...), il y a le faciès de la variété, de la race, de la forme, il y a le faciès de l'individu.

Il faut retenir que les variantes de valeur économique ne sont, le plus souvent, que des différences variétales, des particularités individuelles. Qu'importent au cultivateur le nombre et la disposition des pièces florales; et pourtant voici que quatre pétales en croix donnent "l'air des Crucifères" et rapprochent, dans nos potagers, des individus assez dissemblables de forme par ailleurs, tels: le chou, la moutarde roulante et...à la française, le navet, la giroflée, le cresson, le vélar, le radis...Mais prenons une betterave donnant 6% à 8% de sucre; sélectionnons—la et obtenons une génération rendant 12%, une autre rendant 14%, 16%...Voilà une amélioration qui intéresse un cultivateur; M. Vilmorin père a rendu, à la France, ce service. Notre blé Marquis rapportait, au Canada en 1923,, un billion de dollars. La patate Burbank, a donné au marché américain, depuis sa création il y a 42 ans, six cent millions de boisseaux; aujourd'hui, il s'en vend annuellement vingt-cinq millions de boisseaux. Le noyer Paradox, autre création de Luther Burbank, qui pousse, en 14 ans, une tige de 24 mètres de haut et de deux pieds de diamêtre, dont on retire, en 10 ans, 10 cordes de bois au lieu d'une...

Nous pouvons donc parler d'amélioration et laisser de côté ces caractères dont l'association par croisement violerait ces barrières-limites des genres et des espèces que la science moderne respecte de moins en moins. Il sera donc possible de parler d'évolution agricole dans toucher à Patibius ou au Pitèkanthrope, puisque pour réaliser les plus consolants progrès, il suffit de s'adresser à des caractères variétaux ou individuels.

4—Les trois sources de développement

On ne peut plus considérer le sol, ainsi qu'il y a quelque 80 ans, comme un simple compost d'éléments chimiques, garde-manger dont le contenu n'attend pour se transformer en tissus, végétaux par exemple, que le fonctionnement des racines, et dont le coefficient d'efficacité s'établit par l'analyse chimique du sol d'une part, et d'autre, par celle du végétal y planté. Il est encore moins permis d'assimiler les individus d'une race à une collection bien uniforme d'appareils équivalents qui assureraient la nutrition et la reproduction de façon identique.

La mécanique, celle du sol en particulier à son tour s'est réclamée de la partie, et à bon droit; elle a une action incontestable sur le développement des plantes. Pourtant, ces deux maîtresses sciences, considérées isolément ou ensemble, se sont montrées impuissantes à résoudre en bien des cas, le problème de la fertilité des sols. La précocité dans le développement des vivants leur échappe complètement.

La Biologie eut enfin son mot à dire avec ses nombreux facteurs...La fécondité ne doit donc plus être considérée, pas plus que la précocité, comme l'attribut d'une seule espèce de facteurs, mais bien comme l'expression d'un groupe complexe d'actions et de réactions du vivant sur son milieu, et vice versa. L'Ecologie a pour rôle précisément d'établir le rapport entre ces influences. Les animaux, pouvant se déplacer, sont plus indépendants de l'ambiance; et malgré cela, les ruminants sont, à la longue, profondément modifiés par la nature des terrains où ils paissent, des plantes dont ils se nourrissent et ces variations sont héréditaires. La plante cultivée et l'animal domestique ont donc un chimisme, une mécanique, et un biologisme caractéristiques dont il faut tenir compte dans tout travail d'amélioration. Et c'est marqués

par ce sceau compliqué que l'animal adulte et la plante mûre se présentent à nous; épais tapis de variantes diverses, sorte d'écran en dentelles dont les dessins superposés se conjuguent, formant des associations de caractères, différant pour chaque individu, et derrière lesquels se cache le type générique, "l'ens non formatum". L'individu que nous rencontrons—et de ceci il faut bien nous souvenir si nous voulons ne pas nous perdre en jugements futiles, en affirmations gratuites,—est la résultante d'une foule de modifications plus ou moins stables, plus ou moins masquées, plus ou moins utiles ou nuisibles.

Avant de tenter toute amélioration de race ou de variété, il importe d'avoir des notions précises sur cet ensemble de caractères, qu'on appelle tantôt modifications, tantôt variations, tantôt fluctuations,—tous ces mots pourtant ne s'emploient pas indifféremment—, qui affectent le vivant et qu'il nous faut connaître avant de prétendre pouvoir en tirer profit. La multitude des variantes que revêtent les animaux et les végétaux est désespérément bigarrée de couleurs et d'aillures on ne peut plus disparates. Il est donc nécessaire de distinguer, de classifier, si nous voulons voir quelque chose. Les classifications proposées sont nombreuses et diverses. On les sent toutes influencées plus ou moins par des circonstances de temps, de milieu, de personnes (de races). Pour les apprécier avec équité, il faut connaître, au moins dans ses grandes lignes, l'histoire de la Biologie de ces 75 dernières années. Ces classifications n'apprécient les caractères qu'extérieurement, ne considèrent que leurs manifestations; elles n'expliquent pas le fonctionnement et la valeur objective de ces particularités individuelles affectant positivement ou négativement le rendement de nos fermes canadiennes.

Suivent deux exemples de classification modernes; j'extrais:

la 1ère de Babcock et Clausen:

A–*Générale*: 1° en dedans ou en dehors de l'espèce.
germinative: combinaison, mutation.
2° *somatique* : modification, fluctuation.

B.–*Spéciale*: 1° en raison de *leur nature*: morphologique, physiologique, psychologique, écologique.
2° en raison *du temps* de leu[r] manifestation: continu[e,] discontinue.
3° en raison de *leur direc[-]tion*: orientée, fortuit[e.]
4° en raison de *leur cause* ecto ou autogénétique.

la 2ème de Dechambre:

A—*Caractères acquis* comprenant de nom[-]breuses espèces suscepti[-]bles ou non de deveni[r] héréditaires.

B–*Caractères héréditaires*:
1–*Hérédité normale*:
a/*homomorphe* (de règle) lorsque le[s] descendants ont la forme des par[-]ents; si au contraire la forme vari[e] l'hérédité est *hétéromorphe*.
b/*homochrone*: le caractère parait che[z] le descendant à l'âge ou il se montr[e] chez les parents.
c/*homotopique*: le caractère parait su[r] la même partie du corps, sur le mêm[e] organe.
d/*réinverties* comportant une interve[r-]sion de la ressemblance au cours d[e] la vie de l'individu....
2–*Hérédité pathologique*:
a/troubles nutritifs; nerveux.
b/maladies infectieuses; organiques,
c/tares osseuses;
d/anomalies; mutilations?

Tenant à notre point de vue, voyons com[-]ment il nous est possible de diviser les ca[r-]actères, de façon à mettre plus en évidenc[e] leurs mécanismes, leur valeur améliorante.

DIVISION DES CARACTERES

5—"Caractères actuels"

La vie est un échange continu de matièr[es] et d'énergies; c'est tout le métabolisme, vita[l] graphique dont la courbe ascendante accus[e] une mise en réserve de forces: *l'anabolism[e]* et la courbe descendante, un déficit: *le cat[a-]bolisme*. Le long de cette courbe complèt[e] à tout instant, la vie des plantes et des an[i-]maux fluctue, oscille autour d'une moyenn[e.] Consciemment ou non, nous nous ajustons i[n-]cessamment à notre milieu. Cet ajusteme[nt] est très souvent passager, d'un moment: [je] me promène au soleil, la circulation de m[on] sang devient plus rapide, la pulsation de m[on] pouls augmente; je retourne au frais, [ma] température redevient normale. Ainsi,

passage d'une plante sous un rayon lumineux déclanche ou modifie une foule d'actions et de fonctions: tropismes, respiration, transpiration, photosynthèse...Nous pourrions appeler "actuels" ou "actués" ces caractères qui durent aussi longtemps que la cause qui les a provoqués. On les a nommés "fluctuations".

6—Caractères acquis

Le milieu peut agir d'une façon plus durable; l'agent, après son départ, laissera sa carte de visite, une trace qui ne s'effacera qu'au bout d'un temps plus ou moins long. L'action du soleil sur le derme des amateurs de bain de lumière, illustre bien cette classe de caractères qui tiennent le milieu entre les caratères actuels ou fluctuations, et les caractères acquis proprement dits, ou modifications; surtout si quelques bons coups de soleil sont venus punir une trop grande familiarité. La villégiature terminée, il faudra du temps à tous ces épidermes rembrunis pour perdre leur air plus ou moins chocolat et redevenir blancs.

Qu'une pareille insolation se produise plusieurs années durant, les pigments asquéreront, d'une façon définitive, le ton grillé. Parmi ces blancs qui vont passer comme fonctionnaires - les militaires anglais, par exemple, - la moitié de leur vie à travailler sous le soleil tropical des colonies, lorsque la retraite sonne, plusieurs d'entre eux reviennent dans leur patrie, avec une peau tellement tannée, basanée, que vainement ils couleront à l'ombre le reste de leurs jours: leur teint est définitivement flétri, c'est un caractère acquis.

Et combien d'autres exemples ne pourrait-on pas citer:

—un muscle longtemps sans exercice qui s'atrophie demeurera atrophié pour la vie;

—le petit orteil, déformé par une chaussure trop étroite, restera tel dans une chaussure large;

—les arbres des régions alpines, "insufflés" par le vent, transplantés au calme, demeurent "insufflés";

—un choc peut donner des palpitations de coeur pour la vie, blanchir les cheveux.

Après ces illustrations, essayons une définition du caractère acquis: "toute particularité morphologique, physiologique, psychologique, provoquée par un changement, permanent ou non du milieu, qui affecte un organisme durant sa vie et le fait dévier de sa normale d'une façon définitive."

7—Appréciation des caractères actuels et acquis

Que penser de ces caractères au point de vue de l'amélioration de nos animaux domestiques et de nos plantes cultivées?

Les premiers, les "fluctuations", ont un rôle très important dans les rendements, annuel, hebdomadaire ou simplement quotidien d'un troupeau laitier, par exemple; dans le développement final d'une plante ou d'un animal. Climat, nutrition, hygiène, apportent ici tout un contingent de variantes actuelles. Le catalogue des Munford Breeders nous présente deux Shorhorns, ayant mêmes parents—deux jumeaux eussent fait un exemple parfait—durant les deux premières années de leur développement, le premier reçut une alimentation optima, le second minima; résultat: au bout de ce laps de temps, le premier pesait 1610 lbs.; le second 360 lbs.

Les fluctuations conditionnent souvent d'une façon très efficace la manifestation des caractères héréditaires et à ce titre seul, elles seraient très importantes.

Que dire maintnant des caractères acquis, de ces caractères qui apparaissent du vivant d'un individu et qui disparaissent ordinairement avec lui (je n'ai pas fait entrer cette particularité dans la définition ci-dessus, afin de ne pas préjuger d'une controverse dont nous parlerons plus tard. Vous achetez une paire de jeunes moutons, vous leur coupez la queue, ainsi qu'il convient; nul de vous n'attendra, j'espère, à la génération suivante, des petits sans queue; ceci ne fait difficulté pour personne d'entre nous. Fait curieux, à peu près dans tous les milieux on croit vaguement à une transmission, pour les générations à venir, des caractères fluctuants ou acquis affectant la présente. Chez les "artistes" qui améliorent plantes et animaux par des croisements dont ils ne comprennent pas le mécanisme—et tous les éleveurs dignes de ce nom, jusqu'à il y a dix ans, en étaient—, cette croyance est franchement superstitieuse; chez les savants, en mal d'évolution, surtout depuis 75 ans, cette croyance est à demi éclairée par des expériences, de valeur si diverse, que le doute, voire l'incrédulité, sont très excusables.

Un jeune étudiant en biologie demanda un jour à son professeur de Philosophie, homme

d'une grande honnêteté intellectuelle:—"Comment se fait-il que Dieu, ayant enlevé une côte à Adam, nous nous trouvions, ses descendants, avec le nombre normal de côtes?" Cette question qui semble enfantine aujourd'hui, et qui, posée par un biologiste à un philosophe, est tout simplement une malice, excita parmi les théologiens de jadis de longues disputes; le grand Cajetan se lança, à cette occasion, dans une interprétation "sui generis" des versets de la Genèse narrant l'ablation de la côte. Mais aujourd'hui que le procès des mutilations semble bien terminé, la distinction entre ce caractère acquis et les caractères héréditaires ne souffre plus difficulté. Ce qui n'empêcha m'assure-t-on, le professeur de philosophie de répondre, l'air embarrassé: "Mon petit garçon, mon petit garçon, ne t'occupe pas de ça!" Une réponse moins peureuse et plus satisfaisante eut été: "Mon jeune ami, nous avons le nombre normal de côtes, parce que l'enlèvement de cette fameuse côte n'était qu'une mutilation, et que les mutilations ne sont pas héréditaires; elles n'ont nul droit d'apparaitre dans les générations ultérieures."

Si nous admettons pour l'instant ce que nous prouverons ailleurs, que les caractères acquis n'améliorent que l'individu, non la race, aurions-nous pour cela le droit de les mépriser? L'affirmer serait une absurdité! Il faut reconnaitre une valeur économique aux caractères fluctuants, malgré leur instabilité, dès qu'ils influent d'une façon sensible sur le rendement; à fortiori devrons-nous cultiver ces modifications qui affectent la plante ou l'animal pour le restant de la vie, pour de longues années. Quelle différence dans la qualité et la quantité de rendement d'un verger de sauvageons ou de pommettiers décapités et greffés de McIntosh et de Fameuses d'une part, et d'autre, de sauvageous ou de pommettiers tout simplement! La transformation est complète.

Les mutilations ne forment pourtant pas le tout des caractères acquis, il en est plus d'une autre sorte, et à leur égard, une question se repose, que j'ai tantôt évitée: "Y a-t-il des caractères acquis, particulièrement des caractères physiologiques, susceptibles de devenir héréditaires?" si oui, il faudra corriger, surtout en Amérique, bien des opinions courantes. Parents, éducateurs, moralistes, médecins, agriculteurs, cette question nous intéresse tous. La théorie de l'évolution organique des espèces, dont le postulat-pivot est exactement la transmissibilité des caractères acquis, y joue sa vie. Avant de faire l'état de cette question—très importante au point de vue du choix des caractères dans notre travail d'amélioration—, il est indispensable de poser une définition des caractères héréditaires, illustrée de quelques exemples typiques. Au reste, le plan de cette étude nous commande.

Les caractères héréditaires seront donc pour nous: "Toute particularité morphologique, physiologique, psychologique:

a/que les parents tiennent de leur souche respective et passent à leurs descendants,

b/dont la cause déterminante a son siège dans le germe où elle est partie constituante."

Nous disons: "dont la cause déterminante...", cause qui agit probablement à la façon d'une condition "sine quâ non"; la science d'aujourd'hui dirait à la façon d'un catalyseur chimique.

Nous disons: "*qui a son siège dans le germe*": siège intéressant, mystérieux, dont nous parlerons dans un instant. Nous opposons, avec Weismann, le germe, siège des caractères héréditaires, au soma, siège des modifications et des fluctuations. Nous disons enfin: "*où elle est partie constituante*", essentielle. Les microbes de la tuberculose et des autres maladies infectieuses, pourront envahir le germe et, par lui, passer d'une génération à l'autre; ces maladies, à tort les appelle-t-on héréditaires, puisque leurs causes déterminantes ne font pas partie constituante du germe; leur siège n'y est qu'accidentel.

Je vous prie d'excuser cette définition à moitié physique, à moitié métaphysique, et son explication obligée; tout définir, et ne pas trop définir, est parfois si difficile!

Ces particularités héréditaires appartiennent à toute la race, non à telle plante ou à tel animal en particulier. Un individu, fut-il seul de sa génération, peut en être privé qui, accouplé avec un parent, fera passer à une génération postérieure cette privé qui, accouplé avec un parent, fera passer à une génération postérieure cette qualité dont il ne jouissait pas extérieurement. On trouve de ces jeux de caractères en nombre dans la formation des principales races de bovidés

actuelles: par exemple: sur 444 sujets de Shorthorns, à une exposition de cette race en 1920, 176 (c'est-à-dire 40%) remontaient en ligne droite; à Whitehall Sultan. De ces 176, 92 étaient nés d'Avondale, fils de Whitehall Sultan. Avondale pourtant fut toujours déclassé à cause de son manque de conformation; puissant raceur, il ne jouissait pas extérieurement de cette perfection de formes qu'il passait cependant infailliblement à ses descendants. Par contre, son frère, Whitehall King, grand champion, en 1908 (où Avondale n'arriva que 4 ème) ne donna jamais que des veaux informes. Il ne faut donc pas confondre existence et manifestation d'un caractère héréditaire. Une qualité peut exister sous deux formes: sous la forme dominante, alors elle se manifeste; sous la forme dominée, alors elle est latente cachée. Cette latence peut durer une ou plusieurs générations; dans ce dernier cas, on parlera d'atavisme. Le caractère peut aussi être latent durant moins d'une génération; certains bébés, tout jeunes ressembleront à tels de leurs parents: à la mère, à l'oncle, qui plus tard tourneront vers tels autres; l'hérédité sera alors réinvertie. Le duvet et les première plumes de plusieurs espèces d'oiseaux sont d'une couleur, alors que le plumage, à l'age adulte est d'une autre couleur; les goélands, jeunes, sont gris, adultes d'un blanc éclatant. La couleur du poils de plusieurs de nos mammifères varie semblablement; nos veaux canadiens fraichement nés, ne ressemblent guère, dans leurs petites nobes chocolat, à leurs mamans! Ces mises en latence sont souvent dues à des actions chimiques et autres, aux hormones en particulier dans tous les caractères secondaires du sexe.

Les caractères héréditaires sont-ils bien nombreux? Assurément très nombreux; c'est par milliers qu'on les compte chez de toutes petites mouches, ayant peu de support héréditaire. Tous ces caractères morphologiques, qui forment la base de la classification, tant en zoologie qu'en botanique, sont héréditaires, puisque seuls, ils sont stables. Quelques exemples:

Présence et absence de cornes;—couleur de la robe;—couleur, longueur et qualité de la laine; — présence ou absence de queue; — caractères plus généraux: la précocité, la résistance à la maladie, au froid, à la chaleur, à la fatigue. Je ne parle pas ici des caractères psychologiques dont l'étude est aujourd'hui, si pousseé, en Eugénique ou génétique humaine. Sans sourciller, je range dans la présente catégorie:—la production du lait;—la production du gras de beurre;—le développement relatif des formes: les profils concaves, convexes;—l'épaisseur de viande comestible des parties charnues;—la rapidité et la vigueur des chevaux de course ou de trait...C'est le chambardement de plus d'un manuel de zootechnie d'auteurs français, que le grand courant lamarckiste a trop incliné vers l'idée, par ailleurs féconde, de l'évolution fonctionnelle. J'ai déjà entrepris l'analyse critique, à titre d'exemple, de la conception d'un zootechnicien bien connu, M. A. Mallèvre, sur le rôle de la gymnastique fonctionnelle; ce travail sera plus qu'utile. Pour le moment, m'appuyant sur les résultats merveilleux obtenus relativement au développement des caractères: rendement en lait, beurre, viande, dans ces milieux où l'on considère ces caractères comme héréditaires, je ne me crois pas trop hardi de les considérer comme tels.

Les caractères héréditaires ne sont pas eulement nombreux, mais ils sont aussi d'espèces très différentes. Tous ne sont pas soumis à une seule loi, leur mécanisme parfois simple, se complique trop souvent de la plus terrible façon..

8—Un mot d'histoire

Depuis des siècles, les humbles en pratique avaient tenu compte, sans le savoir, de cette force qu'on appelle l'hérédité et de ses lois; nous leur devons nos races domestiques. Pendant ce temps, et jusqu'aux 18ème et 19ème siècles, les savants ne la soupçonnèrent même pas ou la méprisèrent. D'après un philosophe anglais (fin 18ème siècle,) Wollaston: "a new life is a fresh start".—Bonnet, naturaliste (français, n'admet que l'hérédité des caractres génériques ou spécifiques, non celle des notes individuelles.—Buckle, psychologue du 19ème siècle, ne reconnait une hérédité que pour les caractères corporels, non pour les spirituels.

Depuis 25 ans, théorie et pratique se sont donné la main pour le bien commun. Mendel, moine augustin, fut le précurseur classique de cette méthode qui fit de lui le Père de la Génétique. Il publia dans les compte-rendus

de la Société d'Histoire Naturelle de Brunn le résultat d'expériences qui firent sa gloire en démontrant l'existence d'un mécanisme destiné à assurer la transmission des caractères héréditaires. Les caractères étudiés par Mendel étaient:

—couleur de la fleur: variétés à fleurs blanches, à fleurs rouges;
—couleur de la graine, des téguments, des gousses;
—hauteur de la tige: variétés géantes, de 6 à 7 pds; variété naine de 1 à 1½pd.
—formes des gousses, des inflorescences.

9—Types de caractères héréditaires

Un 1er type d'hérédité qui a son histoire, est le type mendélien. Les lois découvertes par Mendel n'affirment pas une transmission quelconque des caractères héréditaires, mais de ses expériences il résulte que, 1° les caractères semblent disposés en paires: exemple, géant-nain, rouge-blanc, jaune-vert, lisse-ridé...2° leur apparition se fait dans un rapport bien défini, toujours le même pour une espèce donnée. x.: 3:1 (1:2:1);—(9:3:9:3:1)...3° à la première génération issue d'un croisement, un membre seulement de chaque paire se manifeste: c'est le dominant; l'autre qui passe sa vie sous cap est récessif.

En agriculture, nombreux sont les caractères qui se transmettent selon ce premier type: présence et absence de cornes; d'une façon générale, la couleur des poils. Cette dominance peut être *générale* ou *localisée*; dans ce dernier cas, au milieu d'une robe noire—le noir étant dominant—paraitront des plaques blanches. Les cas d'hérédité qu'on appelle, en France, "*hérédité en mosaïque*", son dus à un état mitigé d'association entre certains dominants et certains récessifs.

Les fleurs, les feuilles de nombreuses variétés de plantes cultivatées se colorent de cette façon. Ainsi, le Coleus, avec sa feuille si brillamment panachée, se prête aisément à l'étude du mécanisme de ces mosaïques. Ayant semé les graines d'un pied de Coleus Blumei—la fécondation s'était opérée sans contrôle—nous avons obtenu prequ'autant de variétés que de graines; un individu à feuilles jaunes, presque vides de chlorophylle, un autre à feuilles vertes et entre ces deux extrêmes une douzaine d'intermédiaires différemment panachés.

Un 2ème type de caractères héréditaires es celui des caractères fusionnants. Dans de croisements entre variétés de volailles noire et de volailles blanches, les éleveurs anglai obtinrent une race gris-bleu, couleur com posée d'un fond blanc disparaissant à dem sous une infinité de points noirs. Cette coul eur impure n'est pas à sélectionner; dès l 1ère génération elle se décompose en sujet noirs et en sujets blancs. Dans le cas précé dent, le "gris acier" n'était toujours qu'un fine mosaïque; la fusion des couleurs peu être plus complète. La variété de Belles-de nuit (Mirabilis Jalapa) à fleurs rouges, fé condée par la variété à fleurs blanches donn une variété à fleurs roses dès la première gén ération. La délayage du rouge et du blanc es parfait, les caractères sont vraiment fusionnés

Un 3ème type d'hérédité qu'il faut con naitre, est celui des facteurs complémentaires Le maïs a rendu d'immenses services à l' étude des caractères héréditaires. Il a con tribué, pour sa part, à faire évoluer la vieill conception mendélienne des caractères-unités Pour Mendel, les caractères étaient des unité indivisibles: tout dominants ou tout récessifs Cependant, d'un croisement entre deux var iétés de Dent, une à grains rouges et l'autre grains blancs, East obtint, (le rapport bihy bride normal étant 9:3:3:1) à la premièr génération, 9/16 blancs; à la génération sui vante, les grains blancs étant fécondés entr eux, quelle ne fut pas la surprise d'obtenir d certains d'entre eux, à la F^3 des épis à grain rouges. La couleur rouge est ici condition née par la réunion de deux unitée, de deu facteurs dont le second complète le premie (R+c=rouge); lorsque R et c sont isolé comme dans les combinaisons RR ou cc, l couleur est blanche. La découverte de c type d'hérédité a apporté une clef très pr cieuse à tous ces retours de caractères laten depuis trois, quatre ou cinq générations e plus; les cas d'atavisme, de réversion, y r çoivent une explication très satisfaisante.

Les caractères *cumulatifs* constituent u 4ème type d'hérédité.

A coté des caractères qualitatifs, il y a l masse des caractères quantitatifs, autreme plus intéressants pour nous, qui nous o cupons d'agriculture; la plupart d'entre eu appartiennent au présent type. Ils apparai sent dès la première génération, plus c

moins manifestés, plus ou moins intenses. Tels seraient entre autres les caractères: —ponte des oeufs, rendement laitier, teneur en gras, vigueur et rapidité des chevaux, précocité et résistance...

"La fonction crée l'organe, disaient les "lamarkistes; c'est par la traite que se sont "développées, chez nos vaches laitières, la "mamelle, la fontaine de lait et autres "veines caractéristiques. C'est en faisant "courir les chevaux de course qu'on a élevé "leur record de vitesse au point où il est "aujourd'hui."

Bien que des études antérieures m'eussent prévenu contre l'évolution fonctionnelle, j'ai longtemps senti le besoin d'établir une troisième classe de caractères, tenant le milieu entre les caractères acquis et les caractères héréditaires. Ne trouvant nulle part, dans les écrits des génétistes actuels, ce juste milieu, compromis qui n'eut satisfait probablement personne, le parti de la prudence l'a emporté et j'ai renié ce troisième groupe-moyen dont les limites et le fonctionnement seraient encore à trouver.

On ne peut pourtant pas équiparer tous ces grands caractères, contrôlant la production que je viens de nommer, et qui cumulent d'une génération à l'autre. Ils sont en réalité des associations de caractères plus élémentaires. Rendement laitier et rapidité des chevaux de course par exemple, ne sont pas non plus héréditaires aux mêmes titres. Le rendement laitier, au dire des néo-lamarkistes eux-mêmes, ne dépend immédiatement qu'en partie de la gymnastique fonctionnelle; le développement des mamelles et celui des glandes mammaires sont des caractères secondaires du sexe, et comme tels, ils relèvent en tout premier lieu de l'action des sécrétions internes. Aussi ces développements ne doivent-ils être considérés que comme *médiatement* héréditaires; la présence des hormones, leur abondance, leur précocité, leur activité d'une part, et d'autre la susceptibilité des organes influencés à correspondre peuvent seules être regardées comme véritablement héréditaires.

Les caractères quantitatifs cumulatifs ne sont donc pas acquis au sens défini plus haut. "C'est l'organe qui crée la fonction", dit Cuénot. Ce qui veut dire que la fonction ou l'usage d'un organe ne fait que manifester la présence du caractère héréditaire caché, que mettre en lumière sa valeur maxima. Mais ce maximum, —et voilà ce qui importe,—ne s'accroit que par l'accouplement entre deux individus possédant ce caractère, accouplement qui recombinera d'une manière plus avantageuse, les facteurs des caractères en question, en les empilant, en multipliant leurs doses. Par de solides arguments, expériences récentes ayant tout le controle scientifiques désiré, une école imposante prétend démontrer la validité de ce type héréditaire à formules plus complexes.

Considérons maintenant un 5ème type d'hérédité, que l'on connait bien en pratique. Dieu merci, on en fait assez de fond en appréciation, c'est *l'hérédité corrélative.* Depuis longtemps, on avait remarqué dans la manifestation de nombreux caractères, une certaine union, sorte de solidarité que l'on appela "hérédité corrélative". Mais distinguons.

1° Parmi ces cas de corrélation, beaucoup ne sont *qu'apparents,* qu'effets du hasard, qu'accidentels. Ex: étendue de l'écusson=rendement laitier; cornes tirebouchonnées (des moutons)=laine nerveuse, ondulée; robe crême (de la vache)=rendement. Dans tous ces caractères, aucune corrélation biologique, puisqu'on a réussi à les isoler par croisements.

2° En d'autres cas, il y a corrélation, mais de caractères *non héréditaires.* Ex:—plus grande excitabilité nervo-musculaire va de pair avec affinement des formes,—longueur du cou s'approprie à la taille,—plus grande vitesse demande des muscles plus longs. Ces modifications relèvent de la loi des corrélations organiques.

3° Mais en dehors des précédents cas, de corrélation fictive ou simplement somatique qui disparait avec l'individu, il y a une corrélation vraiment héréditaire qui se retrouve dans les descendants et dont les caractères constituants ne se peuvent isoler par ségrégations mendéliennes. Cette corrélation au reste, se comprend, bien plus elle s'impose, pour le plus grand nombre des biologistes, pour ceux qui placent le siège de l'hérédité quelque part.

10—Base physique de l'hérédité

Ici, l'étude des caractères devient difficile et nous courons risque de n'y plus voir goutte, si le status de l'hérédité n'est sur l'heure déterminé, si son lieu n'est marqué d'une façon aussi précise que possible.

(à suivre)

BIBLIOGRAPHIE

"Pour la terre et le foyer"

Par M. Alph. Désilets, ingénieur agricole, préface de M. Edouard Montpetit.

Notre excellent confrère et ami, monsieur Alphonse Désilets, Chef du Service de l'Economie domestique, au Département de l'Agriculture de Québec, est, depuis longtemps déjà, fort avantageusement connu, au Canada et aussi en dehors de nos frontières, par son oeuvre poétique, parue en quatre recueils qui s'échelonnent entre les années 1909 et 1924.

Aujourd'hui, sous le titre mentionné plus haut, l'agronome poète nous présente un volume de prose où la ferveur patriotique, l'amour du sol et des saines traditions ancestrales ne sont pas moins vibrants que dans ses strophes. De plus, à côté de la valeur littéraire, ces pages renferment tout un enseignement et une foule de considérations du plus haut intérêt pour les agronomes, éducateurs, éducatrices, économistes, fermières et ménagères, en un mot pour tout le monde qui s'intéresse de quelque manière que ce soit aux conditions rurales de la province de Québec.

Le seul fait d'ailleurs que monsieur Edouard Montpetit ait bien voulu honorer d'une préface le recueil que vient de publier Alphonse Désilets, en dit plus long sur sa qualité que bien des commentaires élogieux.

Les sous-titres de "Pour la terre et le foyer": "*Economie rurale et domestique*", "*Education et sociologie*", laissent déjà soupçonner qu'une bonne part du contenu doit être formée de la substance des leçons, conférences et discours que l'auteur a donnés ou prononcés au cours de ses longues tournées à travers la province, en qualité de directeur des cours abrégés et d'organisateur des Cercles de fermières.

Si la lecture confirme l'augure, elle nous apprend encore qu'une partie non moins importante est le fruit d'un talent d'observation toujours en éveil et d'une âme profondément méditative que possède Alphonse Désilets à l'égal du vénéré monsieur Marsan, de pieuse mémoire, dont il nous retrace avec émotion le portrait au cours d'un chapitre où il se réclame aussi comme son disciple.

Tout le long de ce recueil didactique autant que littéraire on s'aperçoit que l'auteur s'efforce de conserver jalousement à notre milieu rural le cadre des vieilles traditions apportées de France, aux lignes si pures et aux tons si harmonieux, qui entoure le tableau nécessairement changeant et aux teintes parfois criardes qu'impose le progrès presque déconcertant des sciences mécaniques et l'évolution des méthodes économiques modernes.

Il sait trop bien, en effet, que ce cadre, vénérable autant que charmant, forme la véritable sauvegarde de la race canadienne-française comme entité, dans le fameux creuset américain dont l'ardeur a fondu et absorbé toutes les autres nationalités venues d'Europe, en un alliage banal.

Si la lecture de "Pour la terre et le foyer" se recommande, comme nous le disions, à tous ceux qu'intéressent les problèmes ruraux dans la province de Québec, il est évident qu'elle s'impose avant tout aux lecteurs de la Revue agronomique canadienne. On peut se procurer ce beau volume de 216 pages, à raison de 75 sous chez les libraires, et pour 80 sous, par la poste, chez l'auteur: Alphonse Désilets, 35, avenue Cartier, Québec.

H.M.N.

ACTIVITES DES SECTIONS

Section de Montréal

Pour apporter une variation au programme ordinaire des diners-causeries de la section, il a été décidé de remplacer de temps en temps la conférence par une visite à l'une ou l'autre industrie ayant des rapports plus ou moins étroits avec l'agriculture. Cette politique a été inaugurée avec un vrai succès, le 20 février dernier, par une visite aux belles installations de la Montreal Dairy dont les correspondants de plusieurs quotidiens de Montréal, qui nous accompagnaient, ont déjà donné une relation détaillée dans les journaux du lundi suivant.

Notons seulement que nous eumes le plaisir de compter parmi nos hôtes, au diner du cercle universitaire, messieurs M. I. Monette et Adélard Fortier respectivement président et vice-président de la Montreal Dairy, ainsi que monsieur M. L. Bourgoin, professeur de chimie industrielle à l'Ecole Polytechnique et chimiste en charge du laboratoire de la grande laiterie montréalaise. Invité par M. H. M. Nagant à prendre la parole, monsieur Ad. Fortier, ancien président de la Chambre de commerce de Montréal, démontra par son

discours qu'il était aussi bien au courant des problèmes agricoles de notre province que des questions qui concernent le commerce et l'industrie proprement dits. Il affirma aussi sa foi dans l'efficacité du travail des agronomes et la nécessité de leur assurer un traitement en rapport avec leurs connaissances techniques et les services rendus.

Par quelques données statistiques, le vice-président de la Montreal Dairy fournit une idée de l'importance de l'industrie de la distribution et de la transformation du lait dans une ville de la population de Montréal qui consomme journellement 75,000 gallons de lait, et pourrait en consommer encore bien davantage.

Après cela, on se rendit au siège de la Montréal Dairy, situé au numéro 290 de la rue Papineau, dans les automobiles mises gracieusement à la disposition des agronomes par la direction de la Société. L'accueil le plus charmant les y attendait et ce fut avec un vif intérêt que tous suivirent les opérations que subissent chaque jour les énormes quantités de lait, depuis la réception jusqu'à la distribution ou la transformation en crème, beurre, etc. Le professeur Bourgoin se chargea aussi de montrer le fonctionnement du laboratoire de contrôle et de recherche qui assure la parfaite qualité des produits livrés à la population de Montréal. Remarquons que c'est à la Montréal Dairy que revient l'honneur d'avoir été la première institution du genre, à Montréal, à reconnaitre la nécessité de recourir à un technicien parfaitement au courant de la chimie et de la bactériologie pour organiser et diriger ce laboratoire de contrôle.

Monsieur Gustave Toupin, le dévoué et actif secrétaire de la section de Montréal, se chargea de remercier ces messieurs pour l'après-midi aussi instructive qu'agréable, passés dans cette véritable usine, reluisante de propreté, qui assure l'écoulement dans de parfaites conditions d'une si importante partie de la production laitière drainée, c'est le cas de le dire, de nos campagnes.

H.M.N.

Concerning the C.S.T.A.

CONCERNING THE C.S.T.A.

A new local branch of the Society was organized at St. Catharines, Ont., on Saturday, February 20th. This branch (Niagara Peninsula) starts with a membership list of twenty-six, all resident between Hamilton and Niagara Falls. It will hold monthly luncheon meetings on the second Saturday of each month, alternating between St. Catharines and Grimsby.

The next luncheon will be held at the Welland Inn, St. Catharines, on Saturday, April 10th. The Niagara members would be very glad to have any other members who may be in the district that day, join them to renew old friendships and make new acquaintances. Those who may plan to be present should notify A. R. Milne, Secretary, P.O. Box 107, St. Catharines, a few days in advance, so that he may make necessary arrangements as to numbers.

An oil painting of William Lochhead, Emeritus Professor of Entomology and Zoology in Macdonald College of McGill University, was unveiled on March 17th by Sir Arthur Currie, Vice-Chancellor and Principal of the University. The portrait was painted by Mr. G. Horne Russell, President of the Royal Canadian Academy, on subscription of a large number of Prof. Lochhead's colleagues, former pupils and other friends.

A preliminary announcement concerning the C.S.T.A. Bureau of Records and Employment is now being prepared and will be mailed to every member of the Society in April. It is hoped that the Bureau will be sufficiently organized at the time of the Annual Convention to permit a careful consideration of its merits and possibilities.

The programme for the Sixth Annual Convention, to be held at the Chateau Laurier,

Ottawa, from June 23rd to June 26th, is now well in hand. Several committees are co-operating with the General Secretary in the arrangement of details, and those who are planing to attend this important event are assured of an enjoyable and profitable four days. The final programme will not be completed before May 15th and will be mailed to all members about May 31st. In the meantime remember the dates—June 23rd to 26th—and the place—Chateau Laurier, Ottawa.

The Civil Service Commission at Ottawa is asking for applications to fill the following positions:—

(1) Three assistant entomologists, one each for Nova Scotia, Ottawa and Saskatoon, at a salary of $160.00 per month.

(2) Three junior entomologists—two for British Columbia and one for Hemmingford, P.Q., at a salary of $125.00 per month.

(3) Eleven Insect Pest Investigators for temporary employment at $100.00 per month.

(4) Ten Inspectors of Insect Pests for temporary employment at $75.00 per month.

Application forms, properly filled in, must reach the Civil Service Commission, Ottawa, not later than April 15th. Qualifications for the positions listed under (1) and (2) include University graduation, for those under (3) two years at an agricultural college and for those under (4) primary school education with some knowledge of horticulture and entomology.

Local branch meetings have been held so frequently during the past two months that it is hard to keep track of them. The annual meeting of the British Columbia branch was held at Vancouver on March 18 and 19, of the Eastern Ontario branch at Ottawa on March 30th, and of the Ste. Anne de la Pocatière branch at Ste. Anne on March 23rd. Monthly luncheons are being held by the Niagara and Montreal branches; the branch at Toronto has a luncheon every second Friday at the Engineer's Club. A meeting of the New Brunswick Branch is to be held at Moncton on April 8th, to be addressed by H. S. Arkell, Dominion Live Stock Commissioner and Harvey Mitchell, Provincial Deputy Minister of Agriculture. Notices of meetings in the prairie provinces have not been received recently but we known that the Society is developing rapidly in that part of the country.

Percy Reed, President of the local branch at Regina was in Ottawa recently, attending a dairy conference. C. P. Marker, Dairy Commissioner for Alberta, was also in attendance.

R. D. Colquette (O.A.C. '15) who has been Professor of Marketing Economics at the Ontario Agricultural College since 1922, has been appointed Associate Editor of the Grain Growers' Guide at Winnipeg. He was Associate Editor of the same paper from 1917 until 1921.

C. P. Killick (Saskatchewan '24) is now with Caulder's Creamery at Wolseley, Sask.

W. G. McGregor (O.A.C. '24) is with the Cereal Division at the Central Experimental Farm, Ottawa.

K. W. Neatby (Saskatchewan '24) has been appointed to the staff of the Dominion Cereal Division, with headquarters at the Manitoba Agricultural College.

E. A. Atwell (Macdonald '23) is at present in Windsor, Ont. His address is 122 Josephine Avenue.

The following O.A.C. graduates were in serious conference at the Chateau Laurier, Ottawa, during the recent visit of the Ontario Seed train to Eastern Ontario:—L. H. Newman ('03), W. J. Squirrell ('07), E. P. Bradt ('12), P. Stewart ('14), W. J. Bell ('15) and E. K. Hampson ('15).

Ballots for the annual election of the four named officers of the Society for the year 1926-27, will be mailed to each member on April 10th. Be sure to register your vote. Nominations will be closed promptly on March 31st, and referred to the Ballot Committee.

Members are urged to notify the General Secretary of any changes which should be made, either in their official title or address, in the list of members recently published by the Society.

Coli Types and Ropy Milk.

Case of Ropy Milk caused by an a-typical Escherichia neapolitana.

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Introduction

The results of a study of coliform or-anisms responsible for a case of ropy milk re presented in this paper.

Ropy or slimy milk is one of the best known f the abnormal fermentations which, from me to time, appear in milk supplies. As e condition is so well defined, a detailed escription is quite unnecessary at this time. rganisms responsible for ropiness, as it is sually understood, are never found in the ormal udder of the healthy cow; and the rmentation with which we are concerned ust not be confused with the stringy milk ften observed when milking a cow having arget or inflammatory conditions in the ud-er. The ropiness to be discussed herein is ot a pathological condition, but is distinctly ndesirable, and is directly responsible for conomic loss, because the milk so affected is nmarketable. The one qualification to the oregoing, is that certain of the true lactic acid roducing strains used in the preparation of ilk beverages produce a ropy condition not ndesirable but peculiar to the particular everage.

Organisms causing ropy milk were among ose studied by the earlier bacteriologists; nd a review of the literature indicates that utbreaks of ropy milk, in widely separated ocalities, have been traced to certain well de-ned types of organisms. Many epidemics ave been caused by strains of *Bacterium erogenes* (Escherich)—see Buchanan and ammer (1); while, for possibly the greater umber of recorded outbreaks, organisms of e *Bacillus lactis viscosus** (Adametz) type ave been responsible—see Buchanan and ammer (1), Golding (2) and others.

For an informative historical review of the elation of micro-organisms to outbreaks of opiness in milk, and also in beer and wine, it is suggested that the paper on "The Viscous Fermentation of Milk and Beer" presented by Harrison (4) in 1905 to the Royal Society of Canada, be consulted. Further, an excellent treatise on ropiness in milk is the monograph on "Slimy and Ropy Milk" (1915) by Buchanan and Hammer (1). Not only do Buchanan and Hammer report on cases which have come under their own observation, but they present an extremely valuable summary of work published up to that time, and give a detailed description of the various micro-organisms associated with specific outbreaks of the trouble.

As the present paper concerns itself entirely with a case of ropiness in milk directly traceable to strains of the *coli-aerogenes* group, a rather free use of the above mentioned monograph has been made. We cite from Buchanan and Hammer (1) as follows:

> "Freudenreich (1890) in a study of the organisms which are capable of producing gas in cheese, found one species capable of producing viscous milk, the *Bacillus guillebeau c*..... Emmerling (1900) noted a tendency of *Bacillus lactis aerogenes* to become viscous upon continued cultivation in milk....Schardinger (1902) isolated *Bacillus lactis aerogenes* or some closely related organism, from water and noted its property of making milk slimy.....Utz (1904) noted the tendency of cocci and *Bacterium lactis aerogenes* when grown in milk to develop ropy strains and races."

Buchanan and Hammer (1) studied three cultures of *Bacterium aerogenes* and found each to be capable of producing extreme ropiness in milk. Harrison (4) (1905) worked on two strains of *Bacillus lactis aerogenes*, one isolated from milk, and one from the air of a cow stable, each of which produced viscosity in milk. Sadler (5) (1917) classified as *B. aerogenes* a strain isolated from water which produced sliminess in milk, the milk roping to the extent of two feet. Mounce (6)

*This organism, in harmony with Bergey's (SAB) Determinative Bacteriology (3) is now classified as *Lactobacillus viscosus* (Adametz).

recovered from a farm well, a strain of *Bacterium aerogenes** which produced in milk a ropy sediment.

It is to be seen that while *Bacillus lactis viscosus* (*Lactobacillus viscosus*) is the more common cause of ropiness in milk—see page 297—the literature records not a few well authenticated cases where strains within the main *coli-aerogenes* group have proved to be the causative organisms.

The Present Investigation

In the fall of 1922, ropiness appeared in the milk produced on a small holding in the vicinity of the City of Vancouver. From a bottle of milk brought to the laboratory, organisms causing ropiness were isolated, and at once a visit was paid to the premises on which the milk was produced. Observing the necessary aseptic precautions,** milk direct from the udder of a cow was drawn into sterile test tubes, and the following additional samples were taken:—a bottle of milk ready for consumption; dried feed; litter which had been used as bedding for the ca tle; washings from a presumably clean pa immediately before milking, using steri water; entire milk, in pail, of one cow; san milk after straining; tap water,—the supp used in all cleansing operations.

No bacteria capable of causing ropine could be found in the milk taken direct fro the teats, when aseptic precautions were o served. It is thus indicated that the infecti organisms arrived in the milk during or su sequent to the operation of milking; or, du ing *and* subsequent to the milking operatio Organisms which produced ropiness, when i oculated into sterile milk, were isolated fro the bottle of milk ready for consumption, l ter used as bedding for the cattle, washin from a presumably clean pail immediate before milking, the entire milk of one co in pail, and from the same milk after strai ing. A few days after rope-producing o ganisms had been found in the samples deta ed above, a second visit was paid to the hol ing. The operations associated with the mil ing were conducted according to the usu custom, and a bottle of milk was broug back to the laboratory for examination. Fro this sample, organisms producing ropiness milk were recovered.

* The names used for this organism are in accordance with the nomenclature employed at the particular time the papers referred to were published.

** The udder and teats were washed with 1% lysol, then with sterilized water, and were dried with a sterile towel.

CULTURAL STUDIES:

Media Employed

Beef-peptone-agar	Dessicated (Difco) (7)
or	
Beef-peptone-agar	Standard Methods for Water Analysis (8)
Whey Agar	Dessicated (Difco) (7)
Purple lactose-agar	Dessicated (Difco) (7)

Media for Fermentation Determinations.

For determining the reactions of the organisms to the various carbohydrates, solid media were used entirely. Nutrient agar was made up, subdivided, the required carbohydrate at the rate of ½% added, and brom-cresol-purple added as indicator. The media were then sterilized in the autoclav.

Nutrient Gelatin	Standard Methods (8)
Medium for Methyl Red Test	Standard Methods (8)
Medium for Voges-Proskauer Test	Standard Methods (8)
Peptone Medium for Indol Production	Standard Methods (8)
Nitrate Agar	Manual of Methods (9)

Litmus Milk

Fresh milk was separated, sufficient azolitmin solution added to give the desired colour, was tubed, and heated for 30 mins. in flowing steam for 3 successive days.

With numerous strains, preliminary determinations on various media were made. Resulting from these determinations, 19 cultures were selected as being representative of the bacterial flora of the samples from which rope-producing organisms had been recovered. Eighteen of the 19 strains were then subjected to more detailed studies in order that further eliminations might legitimately be considered. Comprising the 19 cultures studied were 5 from the original bottle of milk received, 2 from the bottle of milk taken on the first visit, 1 from the bottle of milk taken on the second visit, 1 from the litter used as bedding, 4 from the milk of one cow in pail, 4 from the same milk after straining, and 2 from the presumably clean milk pail rinsed with sterile water.

With the exception of the strain isolated from litter, the cultures were grown in glucose agar, lactose agar, saccharose agar, and salicin agar, employing the shake culture method, in order to determine the ability of the organisms to produce acid and gas from the carbohydrates defined; the reactions to gelatin were determined, tests for indol formation were made, and each culture was incubated in the special broth for the Methyl Red Test and the Voges-Proskauer Test respectively. The nature of the growth on purple lactose agar and on whey agar was observed and special attention was paid to the effect each organism had on litmus milk. Briefly, the results were as follows:—the 18 cultures fermented all the carbohydrates tested to acid and gas, a preference being shown for room temperature (21°C) rather than for blood heat (37°C); gelatin was not liquefied; indol was not formed; the majority of the organisms gave a positive reaction to the Methyl Red Test; while all clotted and bleached litmus milk with evolution of gas, after several days. One strain from one sample showed capsules on whey agar, and with one other strain capsules were observed when grown in milk. The reactions were determined in the fall of 1922, and in the spring of 1923.* Based on the results obtained, a further elimination of strains suggested itself. Representative cultures were put in nutrient agar stabs, were sealed to prevent drying out, and placed in the culture cupboard. Presssure of other activities interfered at this stage with the completion of the work, and the cultures remained in stock until the spring of 1925. In the meantime, one or two transfers had been made to freshly prepared nutrient agar stabs, and, on November 6th 1924, the cultures had been transferred to agar stabs in Freudenreich culture tubes and again put in stock.

In April 1925, inoculations were made from the Freudenreich tube cultures to glucose agar slopes, and into litmus milk. Each culture produced a definite ropy condition in milk in 21 hours at 21°C. Further transfers to nutrient agar stabs in Freudenreich culture tubes were made.

In October 1925, the systematic cultural work was resumed. Inoculations on purple-lactose agar slopes were made from the nutrient agar stabs in Freudenreich tubes which had been in stock at room temperature for exactly six months. At the same time, inoculations direct from these 6 months old agar stabs were made into litmus milk. The strains from the presumably clean milk pail having been lost in the meantime, six representative cultures were selected as follows:

Culture R_1 Originally from the litter used as bedding.
" R_2 From the original bottle of milk received October 1922.
" R_3 Originally from the entire milk of one cow in pail.
" R_4 Originally from the same milk after straining.
" R_5 From the bottle of milk obtained November 1, 1922.
" R_6 From the bottle of milk obtained November 4, 1922.

On the purple-lactose-agar slopes at 21°C each culture, R_1 to R_6 inclusive, showed luxuriant growth in 40 hours. All were very slimy on the agar, culture R_6 being particularly tenacious. After four days incubation, the purple-lactose-agar slopes were acid throughout, gas holes were to be observed in the body of the agar, and much froth was to be seen at the base of the slope. The growth was still slimy but slime appeared to decrease as the acidity increased. Of more interest, is the fact that each culture in litmus milk produced acidity and a distinct ropiness. The ropy "threads" were not long, but quite definite. After four days incubation, the top layer of the litmus milk had a watery semi-transparent appearance, no clot, but pink. Ropiness had now entirely disappeared. On shaking against the thumb, gas was evident, and much froth was produced.

It is to be observed that the cultures had now been on artificial media, principally nutrient agar, for nearly three years.

The six strains which appeared to have retained their principal characteristic for the length of time indicated have more recently

* For assistance in the cultural work done at that time, we desire to thank Mr. Alex. Zoond and Mr. C. T. Townsend.

been studied again, and in considerable detail.

The More Recent Cultural Studies

NOTE. The media used for these studies were as shown on page 298, except, that, at this time, the dessicated (Difco) nutrient agar was used throughout.

The reactions recorded below, are, as a rule, common to the six strains, cultures R_1 to R_6 inclusive, any variation to this being specifically noted.

MICROSCOPIC FEATURES:

24 hour old milk culture at 21°C.: microscopically short rods, 0.6μ to 1μ long arranged singly or in clumps; Gram negative; stained well with simple aniline stains; capsules not seen using the Welch method and no motility observed.

CULTURAL CHARACTERISTICS:

Beef-peptone-agar: No chromogenesis observed after 16 days at 21°C.

Whey Agar: 24 hours at 21°C; growth abundant, glistening, iridescent, dirty white by transmitted light, growth slightly raised; no discoloration of medium.

Gelatin Stab: Growth uniform throughout, filiform at first, slightly echinate later, no liquefaction after 16 days at 21°C.

Litmus Milk: Ropiness developed in from 7 to 17 hours at 21°C; later, a watery, semi-transparent appearance on top, but no clotting after several days; at 11°C. to 12°C. ropiness produced in from 24 to 48 hours; at 37°C. ropiness not evident, clotting observed in 78 hours.

TEMPERATURE RELATIONS:

Whey Agar: In 24 hours, growth scanty at 11°C to 12°C.; abundant at 21°C.; scanty at 37°C. As shown above, the more suitable temperature for growth in milk, as determined by the development of ropiness, proved to be 21°C.

FERMENTATION OF CARBOHYDRATES:

The preference shown by the organisms for 21°C., led to the fermentation determinations being done at this temperature; recorded after 48 hours incubation at 21°C. The determinations were made in solid media, prepared as shown, under 'media employed', page 298, using the roll tube method: dextrose, lactose, galactose, saccharose, maltose, mannite, dulcite, salic and glycerol, were fermented to acid and g In the case of dulcite, even after sever confirmatory tests, the gas appeared to re-absorbed and the medium again becar neutral to alkaline as defined by the inc cator present.

BIOCHEMICAL REACTIONS, AT 37°C.

Indol Production: Indol not produced.

Reduction of Nitrates: Nitrates reduce using nitrate agar.

Culture R_1 failed to reduce nitrates at th temperature. Incubation at 21°C. was r sorted to, and nitrate reduction was pos tive and definite.

Voges-Proskauer Reaction: Negative.

**Methyl Red Reaction*: Positive.

The Voges-Proskauer and the Methyl Re reactions respectively, for all the cultur R_1 to R_6 were determined after incubatic at 21°C, as well as at 37°C. The results 21°C. were identical with those obtain at 37°C.

THERMAL DEATH POINT

One drop from a 1 cc pipette of a 24 ho old glucose broth culture into litmus mi heated for 10 mins. in a DeKhotinsky the mostat bath. All strains killed at 63°C

Classification

One or two minor discrepancies, such the temperature relation to the reduction nitrates to nitrites in the case of culture F have been observed in the foregoing repo Even so, the six strains studied, cultures F R_2, R_3, R_4, R_5, R_6, are to be considered identical, according to the sum of the cha acteristics determined. A consideration these characteristics suggests that each stra is closely allied to *Escherichia neapolita* (Emmerich) Bergey (SAB) (10), a speci within the main *coli-aerogenes* group. A cording to Bergey, *Escherichia neapolita* (Emmerich) forms indol, and the optimu temperature for growth is 37°C. The strai we are considering here have failed to sho

* During the cultural studies pursued in 1922 a 1923, it was noted that the cultures since nam R_5 and R_6, gave a negative reaction to both t Methyl Red and the Voges-Proskauer tests. V are unable to explain the reason for this. A cording to the more recent determinations, t reactions are uniformly positive to Methyl R in the case of each of the six cultures.

the formation of indol, even after many determinations; and, as we have shown, a temperature of 21°C. is much more suitable for growth than is incubation at 37°C. The original description of *Bacterium neapolitanum* by Emmerich is not accessible to us. The paper by Hans Buchner (Archiv. der Hygiene 1885 III) which we have consulted, reveals no data as to variations in the production or non-production of indol by the "Naples Bacillus," It will be seen, therefore, that we have six strains, identical according to the characteristics reported herein, closely allied to the species *Escherichia neapolitana*, but differing from the true type in that indol is not formed and the optimum temperature for growth is nearer to 21°C. It is desired to draw particular attention to these two significant variations. Yet, considering the characteristics of those species in the *Escherichia* genus which ferment saccharose to acid and gas, we are disposed to place the cultures discussed in this paper as a-typical strains of *Escherichia neapolitana* (Emmerich) Bergey (SAB) (10).

Summary

Summing up, in very brief fashion, the findings of the study reported, it is to be seen:—

1. that of culture R_1 from litter, cultures R_3 and R_4 from milk in pail of one cow, and cultures R_2 and R_6 from bottles of milk ready for consumption and obtained on different days, all produce ropiness in milk:
2. that the sequence of the findings suggests the original infection of the litter with manure, possibly direct infection from day to day, and possibly the perpetuating of the infection through the utensils:
3. that while the organisms have been in artificial media for nearly three years, the rope-producing characteristic has not changed:
4. that all are within the main *coli-aerogenes* group:
5. that the six strains are identical according to the cultural characteristics determined, and
6. that each is classified as an a-typical strain (10) of *Escherichia neapolitana* (Emmerich) Bergey (SAB).

Observations

The ability of the organisms reported upon to retain their characteristics, particularly that of being able to produce ropiness in milk, after nearly three years on artificial media, has some practical significance. Organisms having such a degree of vitality might conceivably be a potential source of trouble, over long periods of time, to those engaged in the dairy industry, unless effective methods, procedures and control be in vogue. On the other hand, the Thermal Death Point determinations prove that effective pasteurization as carried out in the control of city milk supplies—145°F. for 30 mins.—would destroy the organisms, and free the milk from infection. The T.D.P. determinations show further, that, if utensils are thoroughly cleansed and then boiled or treated with live steam —the time varying according to the nature and size of the utensil—the strains we are discussing would be destroyed, and could not be carried on from day to day. The utensils would not be "carriers". The preference of these organisms for a temperature of 21°C. (68.8°F.) rather than that of 37°C. (98.6°F.) is unusual. This characteristic would indicate that the temperatures at which much milk arrives in certain of our cities are ideal for the growth and multiplication of the types and consequently for the development of ropiness. Again, the ability of the strains to produce ropiness at 11°C. to 12°C. (52° to 54°F.) shows that the temperature at which milk on the farm is often kept until shipment to the city, may retard the growth of the organisms, and delay the appearance of ropiness, but will not eliminate or cure the trouble.

The fact that the organisms discussed are within the *coli-aerogenes* group, and are of the main *coli* type is of extreme importance from the standpoint of the milk producing farmer and the purveyor of milk. The organisms within the group noted are a source of trouble to those engaged in the milk, butter and cheese industry. And, while precautions against infection with *coli* types must be taken at all times, an additional reason for the observing of such precautions has been emphasized in this paper—the possibility that a particular strain may possess the added characteristic of being able to produce a condition of ropiness in milk.

Preventive and Remedial Measures

A contemplation of the data discussed herein suggests that outbreaks of ropiness in milk may be less frequent or be entirely eliminated if certain precautionary measures be taken. Furthermore, the characteristics of the organisms upon which we have reported would appear to suggest the nature of the precautionary measures which should be observed. Simultaneously with the preparation of this paper, a Bulletin on "Ropy Milk in British Columbia" (11) has been prepared in the laboratories of the University of British Columbia. Embodied in the bulletin are detailed recommendations defining such preventive and remedial measures as are simple, practical and effective. The suggestion is made, that, in considering precautionary measures, those recommendations be consulted.

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PASTEURIZING DAIRY BY-PRODUCTS

The pasteurization of dairy by-products such as whey and skim milk improves their feeding value and prevents the dissemination of disease among live stock. In a new bulletin on pasteurization as applied to dairying, issued by the Dominion Department of Agriculture, the authors assert that the pasteurization of skim milk and whey prolong the time during which these by-products will retain their original palatability and feeding value. The destruction of pathogenetic organisms in them protect the calves and pigs to which they are fed from contagious d eases. The pasteurization of whey also fects a more equitable distribution of it the patrons of cheese factories, because unpasteurized whey the fat rises quickly the surface and as the whey is drawn fr the bottom a large proportion of the fat mains in the tank. The bulletin, which m be obtained free from the Publicati Branch, Department of Agriculture, Otta describes the different methods of pasteu ing these by-products in factories.

Genetical and Cytological Studies of the Origin of False Wild Oats.

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1. Introduction

In a general survey of studies on the origin of false wild oats, *A. sativa* mut. *fatuoida*, (Huskins and Fryer 1925) it was stated that conclusions from a genetical and cytological investigation of the problem then in progress, would be published as soon as the work was completed. The special field of this investigation was stated to be the elucidation of the actual mechanism involved in producing fatuoids, since the findings of many other workers as well as our own seem conclusively to show that these forms do not arise by natural crossing, as a few authors have claimed, but that they are real mutations from *Avena sativa.* As the work proceeds the complexity of the problem becomes increasingly apparent, and it now seems that complete elucidation may be long delayed. Since, however, the results obtained seem to be of considerable interest and to indicate in a general way the probable mechanism concerned in the origin of fatuoids, it has been thought advisable to prepare for publication a statement of results so far obtained, and to indicate the general direction in which the work is proceeding.

2. Material and Methods

Most of the cytological work up to date has been carried out on three strains of homozygous fatuoids from the varieties Banner, Old Island, and Storm King, and on pure lines of normal *Avena sativa* of the varieties Banner and Victory, and on one strain of *A. fatua.* Recently a number of observations have been made on one strain of heterozygous fatuoids from the Banner variety. Chromosome counts have also been obtained in a few other species of *Avena*, the seeds of most of which were obtained from the Department of Plant Breeding, Cornell University. The Old Island and Storm King fatuoids were supplied by Mr. N. Criddle, Dominion Department of Entomology. The remainder of the material used has been obtained from strains of oats which have been grown at the University of Alberta for a number of years. The homozygous fatuoids from Banner were originally selected from a field of that variety in 1919, and have been propagated at Edmonton in each succeeding year for classroom purposes. Many other strains of both homozygous and heterozygous fatuoids have recently been obtained from various sources.

The cytological study has been confined almost entirely to the meiotic divisions of the pollen-mother-cells. The early observations were made by the iron-aceto-carmine smear method (Belling 1921) and by a modification of it which gave as good results and possesses certain advantages. This modification consists in fixing material in Carnoy's fluid, washing and running down to 75% alcohol, in which it is kept for a few days or weeks until time is available for working with it. The slides are then prepared by the "Iron-aceto-carmine 2" method as described by Belling for fresh material. Slides prepared in this way, sealed with a solution of gum damar in xylol, and kept in the dark, keep in excellent condition for several months provided an excess of iron is avoided. The principal advantages of the modification are that the examination of material can be deferred to convenient times, and that if examination of a few anthers by this rapid temporary method shows desirable stages of division, the remainder of the material can be made into permanent preparations by the paraffin method.

The more recent observations in this investigation have been on permanent preparations made by the paraffin method and stained with Haidenhain's iron-alum-haematoxylin. The principal fixatives used were Carnoy's, and Bouin's as modified by Allen. Carnoy's gave excellent results in some cases but rather

*Now 1851 Exhibition Science Research Scholar.

poor ones in others. Bouin's has given uniformly good results, especially when the air was evacuated immediately on fixation. On the other hand, evacuation has been found undesirable with Carnoy's.

The number of plants grown in the genetical study has been so far rather small owing to the small quantities of heterozygous seeds obtainable. Some data have, however, been obtained from a strain of heterozygous fatuoids of the Banner variety, and from the F_2 of a cross between normal Banner oats and a homozygous fatuoid strain from this variety. A number of heterozygous strains have been multiplied and a number of artificial crosses made, from which considerable data should be secured this year.

3. Cytological Observations

(a) *Avena sativa*, L., VARS. BANNER AND VICTORY.

The meiotic divisions of the pollen-mother-cells in the varieties Banner and Victory have been found to be regular in practically all cases examined. Considerable variation in the size of the different chromosome pairs is evident in early diakinesis, but it becomes less evident as they approach the metaphase. The chromosomes are all paired normally and almost always they all line up evenly on the heterotypic plate. The twenty-one bivalent chromosomes nearly always split practically simultaneously in the anaphase. Very few laggard or "vagabond" chromosomes have been found in these normal oats. The homotypic division follows closely upon the heterotypic and is likewise almost always regular. The microspore tetrads, being formed by two successive divisions, have the bilateral arrangement of microspores. No deviation from this arrangement has been found in this species.

Chromosome counts were made with the greatest certainty in pollen-mother-cells at late diakinesis, mounted by the iron-aceto-carmine method. In permanent preparations the heterotypic metaphase or anaphase seen in polar view were found to be the best for obtaining counts. Twenty-one pairs or twenty-one haploid chromosomes were found in all the many cells which gave clear counts.

These cytological observations are in full accord with the genetic fact that this phylogenetically hexaploid species behaves now a normal diploid.

(b) *Avena fatua*, L.

Observations on pollen-mother-cells about twenty plants of a dark brown, me ium hairy variety of *A. fatua*, referred to *A. fatua* A., have shown the chromosome nu ber and behaviour of this species to be sin lar to that described above for *A. sativa*.

(c) HOMOZYGOUS FATUOID FROM THE BANNER VARIETY

Numerous counts at diakinesis and heter typic metaphase, in both temporary and p manent mounts, have shown this strain homozygous fatuoids from the Banner va iety to possess 21–42 chromosomes, and appears unlikely that any variation in chrom some number occurs at these stages. T progress of the meiotic divisions is also re ular in most of the pollen-mother-cells, b in a significantly large number of cases gre irregularities are found. The earliest sta of division at which these have yet been c served is in diakinesis, where, instead of the chromosomes being conjugated in pai abnormal groupings of three or four chrom somes joined together are occasionally foun In a number of cells containing such abn mal groups, the total number of univale chromosomes has been found to be the n mal forty-two. It is not possible, however, determine with certainty the total number univalents in many of the abnormal cells.

Great irregularities are found from hete typic metaphase to telophase. Many cells found in which all but one, two, or thi pairs of chromosomes are lined up evenly the plate. These odd pairs may be lying an where within the cell. Generally their po tion suggests that they are merely delayed reaching the plate, but in other cases wh they lie at one of the poles it would se that they have either been at the plate an without dividing have left it before the ma mass, or else they are destined never to rea the plate. Occasionally more than three pa of chromosomes are so affected.

Separation of the chromosomes in the het otypic anaphase is frequently very irregul Sometimes the irregularity is a simple o such as the presence of one or a few univ ents at the poles while the remainder are j

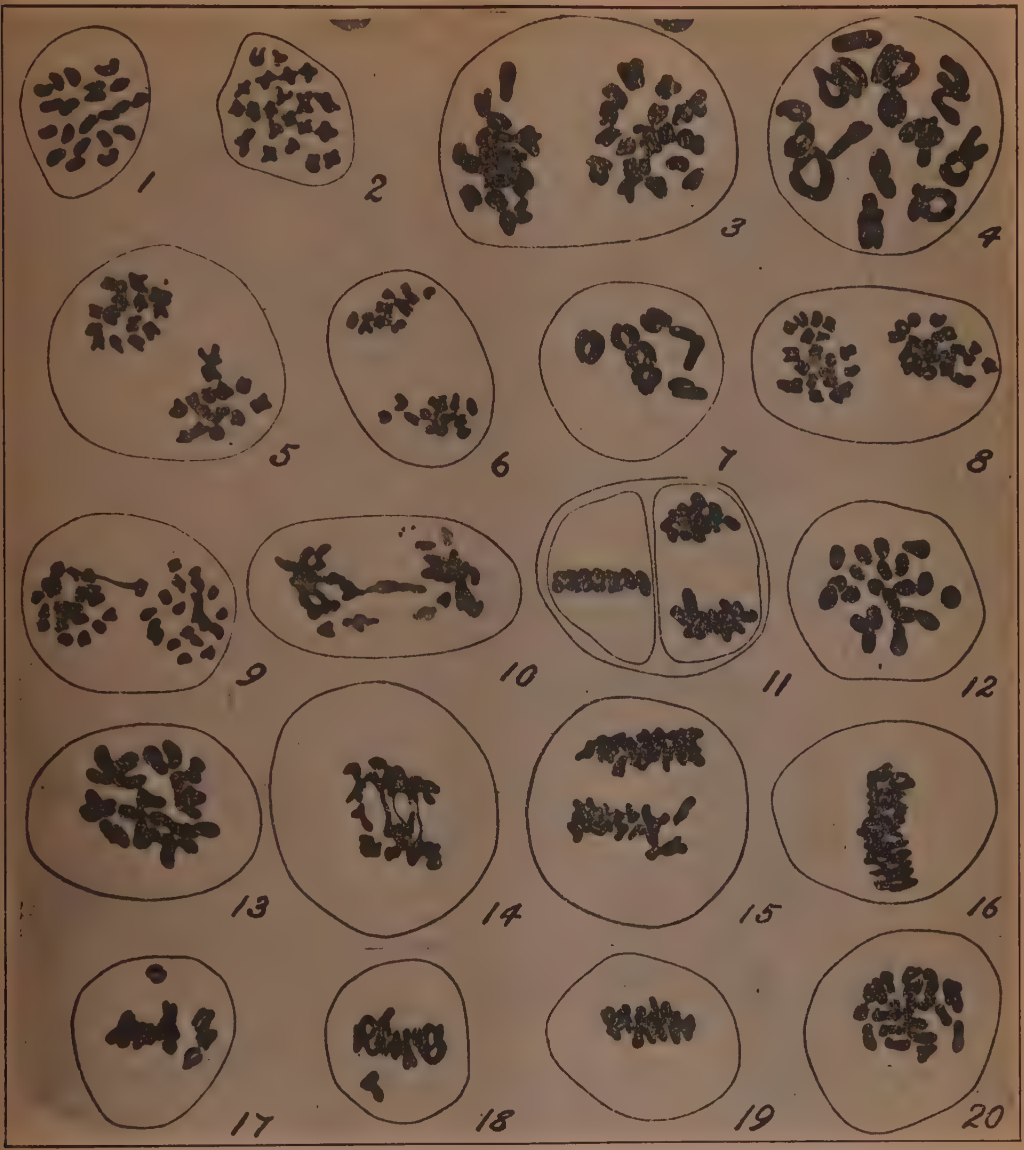

PLATE I

All figures were drawn with the aid of a camera lucida. Permanent, paraffin preparations indicated by "p.p."; aceto-carmine smears by "a.c."

Fig. 1. *A. fatua,* heterotypic metaphase; p.p.
Fig. 2. *A. fatua,* heterotypic anaphase; p.p.
Fig. 3. *A. ludoviciana,* heterotypic anaphase; p.p.
Fig. 4. *A. ludoviciana,* diakinesis; a.c.
Figs. 5 and 6. *A. barbata,* heterotypic anaphases; a.c.
Fig. 7. *A. brevis,* diakinesis; a.c.
Fig. 8. F_1 Banner x Hom. fatuoid, regular heterotypic anaphase; a.c.
Fig. 9. F_1 Banner x Hom. fatuoid, irregular heterotypic anaphase; a.c.
Fig. 10. Hom. fatuoid Banner, irregular heterotypic anaphase; a.c.
Fig. 11. Hom. fatuoid Banner, homotypic metaphase and anaphase; a.c.
Fig. 12. Hom. fatuoid Banner, heterotypic metaphase; p.p.
Fig. 13. Hom. fatuoid Storm King, heterotypic metaphase; a.c.
Fig. 14. Hom. fatuoid Storm King, irregular heterotypic anaphase; a.c.
Fig. 15. Hom. fatuoid Storm King, regular heterotypic anaphase; a.c.
Fig. 16. Hom. fatuoid Storm King; regular heterotypic metaphase; a.c.
Figs. 17 & 18. Hom. fatuoid Old Island, irregular heterotypic metaphases; a.c.
Figs. 19 & 20. Hom. fatuoid Old Island, regular heterotypic metaphases; a.c.

commencing to separate. Very often, however, it is of a more serious nature such as incomplete separation of univalents with strands of chromatin extending right across the cell between the two anaphase groups, or else the chromosomes may appear as a confused mass lacking organization.

It would seem in consequence of these irregularities that unequal numbers of chromosomes must sometimes be distributed to the two poles in the heterotypic division. Numerous counts of anaphase groups seen in polar view tend to confirm this, but it is very difficult to make counts with absolute certainty where the chromosome number is so high and such great irregularities occur.

The homotypic division usually proceeds normally in so far as distribution of the chromosomes is concerned. Occasionally, however, faintly staining masses, suggestive of heterotypic chromosomes undergoing decomposition are seen in the cytoplasm. Another peculiarity is that the spindles of the two daughter cells frequently do not lie parallel. They may be at right angles to each other, or end to end, or in any intermediate position between these. In consequence, irregular-shaped microspore-tetrads are frequently formed.

Microspore-triads are also found frequently. Some of these appear to indicate only a lack of uniformity in the time of commencing the homotypic divisions of the two daughter cells. Had sufficient time elapsed before fixation they would probably have developed into normal tetrads. Other triads were nearing maturity, and they probably would not have formed normal tetrads no matter what time was available for their development.

It might be expected that supernumerary microspores would frequently be formed on account of the irregular divisions. The only evidence of this so far obtained, however, is the observation of one pentad.

Exact studies of the pollen have not yet been made, but preliminary examinations have shown only a small percentage of sterile grains in *A. sativa* and *A. fatua*, but a very large percentage of abortive or abnormal grains in this strain of homozygous fatuoids.

(d) Homozygous Fatuoids from the Varieties Storm King and Old Island.

The variety Storm King is a coarse-growing, white oat with side panicle typical of the sub-species *orientalis* of *A. sativa*. Ol Island is a black-seeded variety of *A. sativ* The homozygous fatuoids from these vari ties are identical with normal plants of thei varieties, except for the distinctive feature of strong, twisted, geniculate awns, and hair "sucker-mouths" on all the grains, and hai on the rachilla, which characterize all hom zygous fatuoids.

The cytological observations on these fatu oids have not been nearly so numerous a those on the fatuoids of the Banner variet but they have been extensive enough to sho that practically identical irregularities occu in the three strains. Likewise, there is n striking difference at any rate, in the propo tion of normal to abnormal divisions in an of them.

(e) Heterozygous Fatuoids from the Vari ties Banner and Victory, and Banner × Fatuoid hybrids.

Recent observations on heterozygous fatu oids from the varieties Banner and Victor and on the three classes of segregates fro these indicate that irregularities of the meio tic divisions occur with greater frequency i them than in the three true-breeding strain of homozygous fatuoids described abov The observations have not, however, procee ed far enough for any statement further tha this to be made. Irregularities have als been found in a few observations made o the F_1 of the cross Banner × Hom. fatuoi Banner.

(f) Other Species of Avena

The following chromosome numbers hav been found in other species of *Avena*: *A ludoviciana*, *A. sterilis* and *A. nuda* 21-42 *A. barbata* 14-28; *A. brevis*, *A. strigosa*, an *A. Wiestii* 7-14. Very few cytological irreg ularities have been observed in any of thes species.

4. Genetical Studies

(a) Homozygous fatuoid from the Banne variety.

In 1924 approximately 600 plants space four inches each way were grown from th strain of Banner fatuoids which had bee propagated for the preceding four years a classroom material. All these plants we of the normal Banner type except for th

presence on them of the typical fatuoid characteristics of the grain. They were a uniform group of plants and gave no indication that the strain is other than a pure line.

(b) HETEROZYGOUS FATUOID FROM BANNER

This strain of heterozygous fatuoids originated from a single heterozygous panicle selected in 1924 from a head-selection plot of "elite Banner" on the University of Alberta Investigation Field. Some seeds of this panicle were propagated in the greenhouse during the winter of 1924-1925. One homozygous fatuoid, three heterozygous fatuoids, and two normal Banner plants were obtained from this sowing. An interesting observation, however, was that under the comparatively slow growing conditions which prevailed at the time these plants were maturing, the normal Banner segregates developed much stronger awns than is usual in this variety under field conditions in Alberta. It was, in fact, rather difficult to distinguish the normal segregate from the heterozygous fatuoids. These two classes of segregates were at the time tentatively distinguished by including under heterozygous only three plants which had heavy twisted awns on all the primary grains. Two plants which showed variation in the degree of awning on different primary grains were classed as normal segregates, even though the awns on some of their grains were very strong. This tentative classification was shown by their progeny to be correct.

These plants in the greenhouse were still immature on May 15, by which time their seeds should have been planted out of doors. All the panicles which were as far advanced as the "dough" stage were therefore gathered, and dried in an oven at 30°–35°C for one week, and most of their seeds then sown in the field. They germinated excellently and gave vigorous plants. Many other panicles matured later in the greenhouse, but their seeds have not yet been sown.

Sixty-four seeds from the two normal but strongly awned segregates gave only normal plants having either no awns or only the few weak awns commonly found on Banner oats. Thirty-two seeds from the homozygous fatuoid plant produced only homozygous fatuoids. The progeny of the three heterozygous plants are shown in Table 1.

TABLE 1.

Progeny of three heterozygous sibs from heterozygous fatuoid, Banner No. 24-20

Parental Plant	Number of Progeny Hom. fatuoids	Het. fatuoids	Normal Banner
Het. fatuoid 25–33	6	16	9
Het. fatuoid 25–34	5	17	3
Het. fatuoid 25–35	53	120	64
Totals	64	153	76
Expectation (1:2:1)	73.25	146.5	73.25

P=0.49 (X^2 test for goodness of fit)

Although the total number of plants from these three heterozygous parent sibs was only 293, they were studied statistically in order to determine if possible whether there was any difference in the vigor or variability of the three classes of segregates. The height measured to the nearest inch on the tallest culm of each plant, and the number of culms per plant which bore mature heads were taken as measures of general vigor. Immature secondary culms which developed owing to heavy rains late in the season were not considered. The results of this study are shown in Table 2.

The greatest difference is seen to be between the standard deviation (S.D.) of the height of the homozygous fatuoid segregates and that of the normal Banner segregates. This difference of 2.00 is nearly seven times the probable error of the differ-

TABLE 2.

Comparison of height and number of culms of the three classes of segregates from heterozygous fatuoids, Banner Nos. 25-33, 25-34, 25-35.

Segregates	No.	Mean Height	P.E. of Mean	S.D. of height	P.E. of S.D.	Mean No. of culms	P.E. of mean	S.D. of culms	P.E. of S.D.
Hom. fatuoids	64	49.26	0.37	4.42	0.26	3.97	0.16	1.93	0.12
Het. fatuoids	153	49.28	0.16	2.99	0.12	4.50	0.11	2.01	0.08
Normal Banner	76	48.70	0.19	2.42	0.13	4.46	0.16	2.01	0.11
Hom. fatuoids minus one weak plant...	63	49.64	0.29	3.41	0.20				

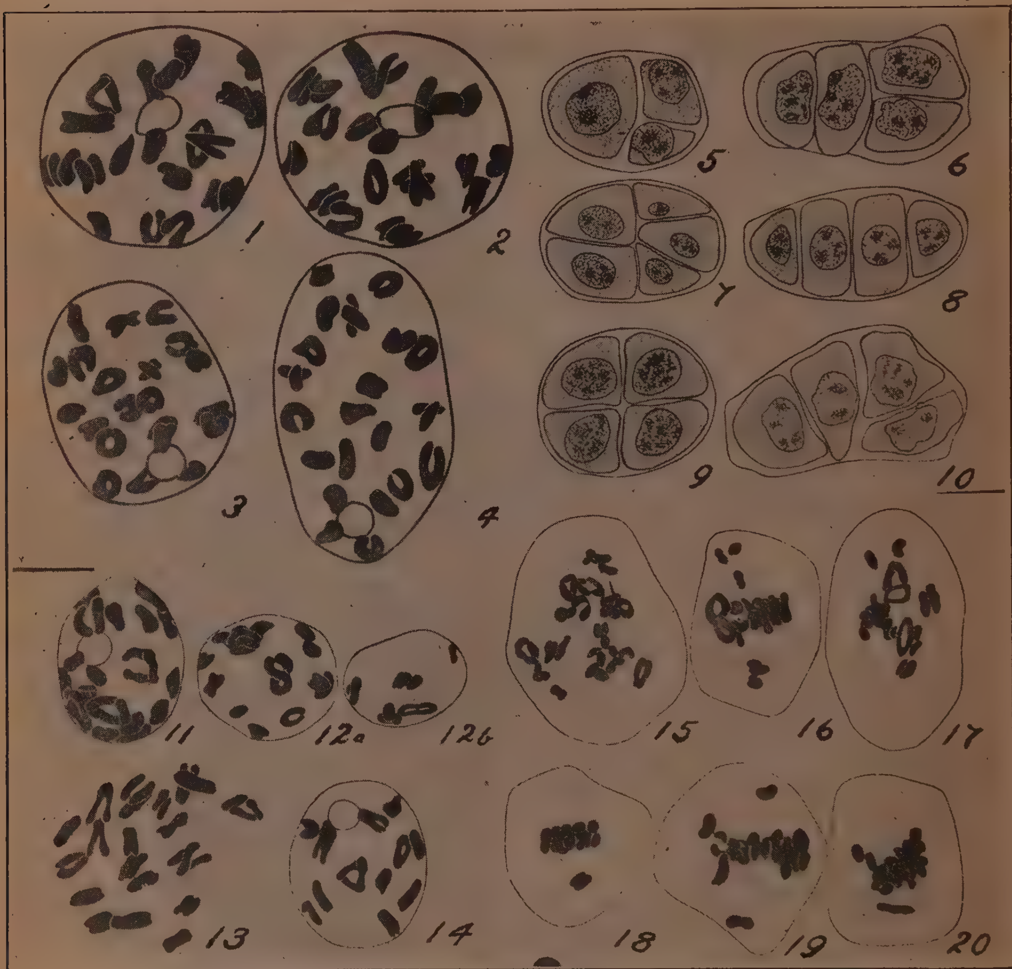

PLATE II.

Figs. 1 & 2. Hom. fatuoid, Banner, regular diakinesis, a.c.
Figs. 3 & 4. *A. sativa,* Victory, regular diakinesis, a.c.
Figs. 5-20. Hom. fatuoid Banner.
Fig. 5. Microspore triad. a.c.
Fig. 7. Microspore pentad, a.c.
Fig. 9. Regular microspore tetrad. a.c.
Figs. 6, 8, & 10. Irregular microspore tetrads, a.c.
Fig. 11. Diakinesis showing trivalent chromosomes, or trisomes, p.p.
Figs. 12a & b. Cut section, showing tetrasome. p.p.
Fig. 13. Diakinesis showing trisomes, a.c.
Fig. 14. Cut section, diakinesis showing trisome. p.p.
Figs. 15-20. Irregular heterotypic divisions. p.p.

ence, viz 0.29. The sixty-four homozygous fatuoid plants here considered included one weak plant only 27 inches high. Calculations were repeated with this plant omitted to see how far it affected the result. As may be seen in the table, the difference between the hom. fatuoids and the normals is much reduced by this omission. The difference, however, is still 1.01, and more than four times the probable error (0.24) of the difference.

The difference between the mean height of the homozygous fatuoids and the normal segregates is only 0.56 inches, with a probable error of the difference of 0.42. Between the standard deviation of the number of culms of these two classes of segregates there is a difference of only 0.08 with a probable error of 0.16.

(c) Artificial Reciprocal Hybrids between Banner and Hom. Fatuoid Banner.

The F_1 generations of reciprocal hybrids made in 1924 between normal Banner oats and homozygous fatuoid Banner, were grown in the greenhouse during 1924-1925 and harvested and sown in May 1925 similarly to the fatuoids described above. These F_1 plants were indistinguishable from ordinary heterozygous fatuoids. The number of F_2 plants grown from them is very small but the progeny of one F_1 plant of Hom. fatuoid x Banner shown in Table 3 indicates quite clearly that the segregation ratio is approximately 1:2:1, the numbers 22:43:26 constituting a very close fit. (P=0.76). The three classes of segregates are likewise indistinguishable from the segregates of heterozygous fatuoids. The difference between the mean height, mean number of culms, and the standard deviation of these in the different segregates is in all cases too small to be statistically significant although the difference in the number of culms verges on significance.

Only twenty-two F_2 plants of the reciprocal cross Banner x Hom. fatuoid have so far been grown. These gave a ratio of 7:8:7. Their height and number of culms have not been considered statistically.

5. Discussion

The cytological irregularities observed in fatuoids appear to differ in certain respects from those reported for any organisms definitely known to be hybrids. In certain features especially the abnormal trivalent and quadrivalent chromosome complexes, they resemble the polyploid *Datura* mutants investigated by Belling and Blakeslee. The presence of unsplit chromosome pairs at one or both of the poles recalls the findings of Gates (1908) and Gates and Thomas (1914) in trisomic *Oenotheras*. Since, however, the majority of Datura and Oenothera mutants have altered chromosome numbers, the situation is substantially different from that in fatuoids which have the normal number of chromosomes. However, the fact that *Avena sativa* though regularly behaving as a normal diploid species, is phylogenetically hexaploid may have considerable significance and cause a difference in cytological appearance, though perhaps not in the essential nature of the mechanism causing the mutation.

Winge (1924) has made the hexaploid nature of common wheat the basis of an hypothesis to explain the origin of speltoid mutations. The cytological findings reported by Winge in speltoids bear a striking similarity to those herein described in fatuoids. Basing his hypothesis largely on his findings of trivalent chromosome complexes in heterozygous speltoids, and of large complexes apparently consisting of four chromosomes in homozygous speltoids, Winge argues that speltoids may arise by a faulty conjugation occasionally occurring between the similar but not identical chromosomes which presumably exist in hexaploid

Table 3.

Comparison of height and number of culms of the three classes of segregates from plant 25-29, an F_1 plant of a cross Hom. fatuoid Banner x Banner.

Segregates	No.	Mean Height	P.E. of Mean	S.D. of height	P.E. of S.D.	Mean No. of culms	P.E. of mean	S.D. of culms	P.E. of S.D.
Hom. fatuoids	22	41.23	0.72	4.99	0.51	4.32	0.29	1.99	0.20
Het. fatuoids	43	43.19	0.33	3.24	0.24	4.81	0.18	1.76	0.13
Normal Banner	26	42.81	0.53	4.01	0.38	5.89	0.42	3.18	0.30

species. Considering the 42 chromosomes of wheat as being made up of seven groups each consisting of six more or less similar but not identical chromosomes, he designates one of these groups as $\frac{A\ B\ C}{A\ B\ C}$. The other groups need not be considered further. Within this group it is obvious from the genetic behavior of wheat that an A chromosome usually conjugates with an A, a B with a B, and a C with a C. Since, however, these three pairs of chromosomes though not identical are similar, it is possible, he says, that a faulty conjugation such as A+A, B+C, and C+B might occasionally occur. Following this the gametes ABB and ACC would probably be formed. If ABB be considered a speltoid-determining gamete, the union of this gamete with a normal ABC gamete would give a plant with the formula of $\frac{A\ B\ B}{A\ B\ C}$ with respect to the six chromosomes under consideration. This formula $\frac{A\ B\ B}{A\ B\ C}$ Winge considers as that of a heterozygous speltoid plant. It is to be expected that it will usually give gametes of the two kinds ABB and ABC in equal proportions, and provided that these have equal functional power the progeny should be normal wheat plants, heterozygous speltoids, and homozygous speltoids, represented respectively by the formulae $\frac{A\ B\ C}{A\ B\ C}$, $\frac{A\ B\ B}{A\ B\ C}$, and $\frac{A\ B\ B}{A\ B\ B}$, and occurring in the ratio of 1:2:1. Many strains of speltoids segregate in this ratio. Divergent ratios are explained by assuming different percentages of non-functioning male and female gametes. Abnormal chromosome numbers and crossovers may account for other complicated forms of speltoids.

Winge's hypothesis is in essence similar to that now termed double-non-disjunction and first suggested by Gates (1908) to explain the origin of certain *Oenothera* mutants. It differs from this principally on account of the hexaploid nature of wheat. The limitations of the hypothesis of double-non-disjunction when applied to *Oenothera*, as well as its advantages were pointed out by Gates (1923). Hypotheses of this type have proved very successful in explaining the origin of some *Oenothera*, *Datura*, and other mutants, and have much to recommend their extension. The hypothesis devised by Winge would, if valid, apply in its simplest form to the majority of fatuo[ids] so far reported, as in these the segregati[ng] ratio does not vary greatly from 1:2:1. [As] will be pointed out below, however, it is pr[ob]able that more divergent ratios and for[ms] will be found as the fatuoid problem is [in]vestigated further. Many of the cytologi[cal] observations here recorded seem to favor t[he] extension of Winge's hypothesis to fatuoi[ds] but it is not clear how all the irregularit[ies] could be explained on this basis, and as [yet] it is felt that the evidence is insufficient [to] warrant its complete adoption. It is, neve[r]theless, a very useful working hypothes[is] and is now being used as such.

Goulden (1925) found extremely irregul[ar] cytological conditions in dwarf oats whi[ch] were segregates from heterozygous fatuoi[ds.] These oats possessed the characters of t[he] glumes typical of homozygous fatuoids, b[ut] they were only about one half the height [of] normal plants, and were completely steri[le.] He reports that there seems to be almost co[m]plete lack of coordination among the chrom[o]somes in the heterotypic division of the p[ol]len-mother-cells, and that the homotypic di[vi]sion probably does not take place. Very fe[w] normal-appearing pollen grains were forme[d.]

The chromosome numbers here reported f[or] various species of *Avena* are all in agreeme[nt] with those given by Kilhara (1919). Excep[t]ing *A. brevis*, they differ from those [of] Nikolaewa (1920) who reported 32 chrom[o]somes in root tips of *A. barbata*, 44 in [A.] *sterilis*, *A. ludoviciana*, and *A. byzantina*, a[nd] 48 in *A. fatua* and *A. sativa*. Stolze (192[5]) reported 21-42 chromosomes in *A. sativa* a[nd] *A. fatua*. He states that Tannert in 1905 fou[nd] 8-16 chromosomes in *A. sativa*.

The genetic evidence here presented su[p]ports the statement of Nilsson-Ehle (1921[),] Garber (1922) and many other workers th[at] both the homozygous fatuoids and the norm[al] segregates breed true. Parker (1925), ho[w]ever, reports that in 20 out of 225 head ro[ws] of homozygous fatuoids from the variety Ka[n]ota one or more intermediate type plants we[re] found. He does not consider that they cou[ld] have been the result of mechanical mixtu[re.] They may be the result of natural crossin[g] but possibly are reverse mutations from t[he] fatuoid back to the normal, he says. T[he] evidence from other studies and especially t[he] fact recorded by Hayes and Griffee (192

that more natural crossing occurs in Kanota than in any other variety of oats studied, seems to favor the natural crossing possibility, rather than that of reverse mutation, but this point must be investigated further.

As mentioned above, it is very probable that as fatuoids are investigated further many divergencies from the usual 1:2:1 segregation ratio will be found. Nilsson-Ehle (1921) reported a tendency towards a reduction of the number of homozygous fatuoids in some strains, but assumed that this could be accounted for by the observation that fatuoid plants are weaker than normals or heterozygotes, and suffer more under unfavorable environmental conditions. As far as the evidence goes, however, there is no measurable difference in the mean vigor of the different segregates in the strain here studied statistically. It does appear, however, that there is more variability in vigor among the homozygous fatuoid segregates in this strain. The elimination of weaker variants may therefore account for deficiencies of fatuoids in some strains where the different segregates are apparently equal in vigor. Goulden (1926) on the other hand, has found deviating ratios that cannot thus easily be explained. In the heterozygous fatuoids from the Banner variety with which he worked, there are apparently three types of segregation, although, as he points out, the numbers are too small to put this on a definite basis. His first type gives the ordinary 1:2:1 ratio. The second gives an excess of the normal plants and some of the fatuoids are dwarfed, but the numbers are much too small to establish this as a definite type, being only 5:15:20. The third type is the most interesting and is also more definitely established. The original plants in this strain gave 18 dwarf sterile fatuoids and 12 "intermediate" (heterozygous fatuoid) forms, but no normal plants. Seven of these heterozygous plants and 10 of the dwarf fatuoids were sibs. When the seven heterozygous sibs were propagated they gave dwarf fatuoids, heterozygotes and normals in the ratio of 60:63:15. Thirteen of these 15 normals were the progeny of one of the seven parental sibs which did not produce any dwarfs. Eliminating this family, the segregation from the other six sibs is 60:55:2. Goulden remarks that there seems to be a tendency towards the production of dwarf fatuoids and heterozygous fatuoid plants of normal height in a 1:1 ratio. The apparent reversal of the one plant of the seven must not, however, be overlooked. In this particular case, dwarfing was completely correlated with the fatuoid character, but other distinct types of dwarfing are, of course, known in oats.

From a cross of normal Banner with a strain of homozygous fatuoids that had originated from it, Goulden obtained in the F_2 the usual three types in the ratio 90:234:106. There was no measurable difference in the height of the three classes of segregates. This result agrees with that of the hybrid herein reported.

The genetical observations herein support the view now generally held that fatuoids differ from normal oats by either a single factor or by one group of very closely linked factors. They give no indication which of these two latter possibilities is correct. Nilsson-Ehle (1921) favors the assumption that a complex unit is involved, but Garber (1922) states that the three characters which most obviously distinguish fatuoids "are conditioned by a single factor difference". Very little evidence on this point has yet been published. A variation in degree of awning which appeared at first to indicate a splitting of the complex assumed, was found by Gante (1921) in one of Nilsson-Ehle's heterozygous fatuoids, but the investigation of it reported indicated that it was only a modification of the character. Nilsson-Ehle is of the opinion, however, that a more thorough study might reveal a breaking of the complex.

Parker (1924) records that the homozygous fatuoids found in Kanota oats are not all alike. "The plants differ in height and at least three distinct forms have been recognized." One type of particular interest is described as having the awns, basal hairs, rachilla hairs, and basal scar typical of homozygous fatuoids, and yet instead of shattering easily, the spikelets are retained on the panicle more tenaciously than in normal Kanota oats.

At a meeting of the Genetical Society, London, Nov. 4, 1925, when the contents of this paper were presented, Mr. E. T. Jones of the Welsh Plant Breeding Station, Aberystwyth, stated that he had obtained "semi-

false-wild oats", that is, forms showing some but not all of the characters of fatuoids from Ceirch-du-bach, a variety of *A. sativa* L, subspecies *Verna*, Marquand, and from the F_5 of a cross Red Algerian by Victory. The former had been found to breed true; the latter had not yet been propagated.

These findings and our general knowledge of the genetics of the basal hairs, basal scar, and awn suggest that the three characters most typical of fatuoids are not always inherited as a unit, and they therefore support Nilsson-Ehle's contention that a group of very closely linked factors rather than a single factor is concerned in their production.

The occurrence of fatuoids in oat species other than *A. sativa* is of particular interest. Among the many variant forms found in Burt oats by Coffman, Parker and Quisenberry (1925) there were a few typical fatuoids. Fatuoids were recorded in Early Ripe or Burt oats by Howes in an unpublished thesis (1908), and Reed and Stanton (1925) record them in Fulghum. It must be noted that the exact botanical history of Fulghum, Kanota, and Burt oats is unknown, but that they may have originated from natural crosses between *A. sativa* and *A. sterilis*. These varieties are now classed by the above authors and others as *A. byzantina* C. Koch, and by Marquand as *A. sterilis culta.*

An oat plant distinctly fatuoid with respect to its awns but otherwise apparently normal *A. nuda* was found by Mr. J.H.B. Smith, Wolf Creek, Alberta, last summer, and sent to the University. These findings of plants with "fatuoid" characters in derivatives of *A. sterilis* and in *A. nuda*, as well as *A. sativa* seem likely to bring the fatuoid mutation into line with the theory of homologous series in variation, expounded by Vavilov (1922). At first sight they appear greatly to complicate the problem, but if one bears in mind the polyploid nature of the genus *Avena* and the probability resulting from this that many of the chromosomes in the hexaploid species may be very similar, it seems probable that some scheme of permutations and combinations among the chromosomes may be worked out which will bring together the apparently divergent facts. At present the most that can be said is that both the cytological and genetical evidence favors the hypothesis that fatuoids originate through a regional or chromosome mutation, rather than a gene mutation. It is overwhelmingly against the hypothesis that they originate directly through hybridization.

6. Summary

1. Great cytological irregularities are found in the reduction-divisions of the pollen mother-cells of fatuoid oats. In the three strains of homozygous fatuoids so far investigated the normal number of univalent chromosomes, viz. 42, appear to be present in all cells at diakinesis, but instead of these forming 21 pairs as in the normal *A. sativa* abnormal groups of three or four united chromosomes are frequently found in a very large proportion of cells in the heterotypic division. Faintly staining masses, apparently chromosomes undergoing decomposition, are occasionally seen in the cytoplasm during the homotypic division. A large percentage of the pollen is abortive.

2. In one strain of heterozygous fatuoids and its segregates, irregularities of the same order as those above, but of more frequent occurrence are found.

3. The following chromosome numbers have been found in the genus *Avena*: *A. sativa, A. fatua, A. nuda, A. Sterilis* and *A. ludoviciana* 21-42; *A. barbata* 14-28; *A. brevis, A. strigosa* and *A. Wiestii* 7-14.

4. All homozygous fatuoids and normal segregates from heterozygous fatuoids have been found to breed true. Homozygous fatuoids, heterozygous fatuoids, and normal segregates in the ratio of 64:153:76 were obtained from a heterozygous fatuoid of the Banner variety.

5. The F_1 generations of reciprocal crosses between normal Banner and homozygous fatuoid Banner, were indistinguishable from ordinary heterozygous Banner fatuoids, and gave similar progenies and ratios in F_2.

6. Statistical studies on the number of culms and height of the three classes of segregates from the heterozygous Banner fatuoid, and from the cross homozygous fatuoid x Banner, show no significant differences in the means of the three forms, but there is apparently a greater degree of variability amongst the homozygous fatuoid-segregates.

7. The evidence is overwhelmingly against the theory that fatuoids arise by natural crossing. They differ from normal oats by either a single factor or a group of factors very

closely linked, probably the latter, and are considered to be true mutations. The cytological observations indicate that some chromosomal aberration, rather than a change in a single gene, is instrumental in causing their appearance. The genetic facts could also best be explained on the basis of a regional change or whole chromosome difference. It is hoped that further evidence will be available shortly.

7. Acknowledgements

This investigation was begun at the suggestion of Professor J. R. Fryer and practically all of the work herein reported was carried out in the Division of Genetics and Plant Breeding, Department of Field Husbandry, University of Alberta, Canada, under the direction of Professors J. R. Fryer and R. Newton. From May to August, 1925, his work at Edmonton was aided by the Research Council of Canada through a financial grant which is hereby gratefully acknowledged. I wish also to thank Professor W. P. Thompson for facilities provided and help given at the University of Saskatchewan during September, 1924. To Professors D. G. Revell and R. F. Shaner I am indebted for facilities provided in the Department of Anatomy, University of Alberta, during the earliest stages of the work in 1924, and to Professors H. K. Hayes, Karl Sax, and John Belling for help given by correspondence during the same period. The work is proceeding now at King's College, University of London, with the aid of a scholarship from the Royal Commissioners for the Exhibition of 1851 and under the direction of Professor R. Ruggles Gates to whom I am indebted for helpful criticism in the preparation of this paper.

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Coefficient of Compactness and Value of Heads of Wheat

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When comparing heads of wheat, both winter and spring varieties, many notes are taken, of which only compactness and value will be discussed here. Compactness of head describes the degree of proximity of the bases of the spikelets to each other. Generally speaking, compactness is a value given to the correlation between the length of head and the number of spikelets. The note, value, has always been taken as an estimate on the good heads of a plant, as also are the other notes. The characteristics generally taken into account for value are compactness, plumpness, length of head, and also the number of spikelets.

These notes, compactness and value, have, in the past, been only an estimate made by the eye. The eye, to observe a difference, must be well trained, but even a well trained eye will tire after several hours work, and then the estimate on one variety will vary. The same note on all plants is not generally taken on the same day, and the judgment of a person will vary from day to day. Again, different observers will be taking the same note and the judgment of two people will not always coincide.

The form of the heads of different varieties also differ. Some varieties have very large, plump kernels, almost touching each other, while in other varieties the kernels are smaller and less plump, and therefore will not be as close. It is easily seen that the head of a large, plump kernelled variety will appear more compact than the head of a smaller, less plump kernelled variety, even though the bases of the kernels of the latter described variety are as close or closer together than those of the former.

With the note, value, an estimate would vary considerably, even with men of long practice, because owing to the several characteristics taken into account it is difficult to get them lined up correctly. When looking over the value notes afterwards the value has no great significance when taken by itself, but must only be referred to in con junction with its various components.

For the above reasons a mathematica note would be more dependable, as it woul always be the same, comparatively speaking From year to year there would be no dif ference which could not be accounted for b probable error. There would also be no fav oritism shown and one variety would hav equal chances with all others. For this rea son, if none other, the mathematical calcu lation should be used. When a mathematica calculation is used for value, just the not for value would need to be taken into con sideration with compactness. Of course plumpness cannot be taken by calculatio very well, but all the other notes used i value are taken by mathematical calculation

To show how undependable an estimat with the eye is, an experiment was performed First the compactness was estimated by th eye and then it was calculated mathematical ly. Both the estimation by the eye and th mathematical calculation were performed a carefully as possible. The value for compact ness varies from 1 to 10, 10 being give for the most compact. The results as give in Table 1 show how undependable the estima tion is. The conclusion is self-evident. Th mathematical calculation is nearly alway lower than the estimate. By the table i shows that the estimate overlaps considerabl Take the value of 8.5 in the mathematica calculation and it has the corresponding val ues of 8, 8.5, 9 and 9.5 in the estimation o the eye.

TABLE 1

To Show Difference Between Estimation o Eye and Mathematic Calculation.

Estimate of eye	Mathematical calculation					Variatio
10.0	10	9.5	9			2 pts.
9.5	9	8.5				1 "
9.	9.5	9.0	8.5	8.	7.5	4 "
8.5	8.5	8.	7.5			2 "
8.	8.5	8.	7.5	7.		3 "

Wherever the head row method, one head for a row plot, is in vogue the compactness can be found very easily. The length of the head is taken in inches and tenths of inches. Then the total number of spikelets are counted. The length in inches is divided into the number of spikelets, giving the number of spikelets per inch. The difficulty now is to get a connecting link between the number of spikelets and a number denoting compactness. The number of spikelets per inch could be used for the coefficient of compactness but a value would be more easily taken up by the mind than a reading of a number of spikelets per inch. This value varies from 1 to 10, 10 being the value given for the most compact head. The number of spikelets per inch on several of the most compact heads was divided into 10, giving the number 1.82. This number was then taken as the connecting link and multiplied by the number of spikelets per inch giving the coefficient of compactness. When the answer was from 8.76 to 9.25 the coefficient was taken as 9, and when from 9.26 to 9.75 the coefficient was taken as 9.5. The number of spikelets per inch is taken correct to the second decimal place.

Example:—Length of head..........................3.9 inches
Total No. of spikelets..................20.
No. of spikelets per inch..............=(20÷3.9)=5.13
Coefficient of compactness............=(5.13×1.82)=9.34=9.5

At some stations the plant row method, that is, when one plant is selected for a row plot, is in vogue, and here the calculation is taken on four of the average good heads. The number of heads vary from eight to twenty, but some of these are late stools and others poor or malformed. To some extent head selection is practised as the poor heads are discarded, and the medium heads are discarded as far as the notes are concerned, the grain only being used, while the good heads are used for note taking. Four average heads are selected out of the good ones. The length and count of spikelets is averaged on these. The length of head is taken correct to one decimal place, and the spikelets to the nearest whole number, if 19.5 spikelets, 20 is the number used.

Example:—Length of head=[(4.1+4.0+3.6+3.7)÷4=15.4÷4=3.85]=3.9
Total No. of spikelets=(74÷4=18.5)=19
No. of spikelets per inch=(19÷3.9)=4.87
Coefficient of compactness=[(4.87×1.82)=8.86]=9.

It is better to use four heads rather than only three as the error will be less. The use of only four heads may be questionable as the number of good heads on a plant vary from five to fifteen. But on actual measurement it has been found that four heads carefully selected will give practically the same length and number of spikelets as when the total number of good heads are used. Of course five heads might be selected instead of four to overcome the variation but not enough to warrant the extra time used. Table 2 backs up this statement quite well.

It will be noticed in Table 2 that although there may be a difference between the coefficient of compactness of the four heads and that of the total number of heads, this difference is not so marked in the column "spikelets per inch". The difference is nearly doubled by multiplying the number of spikelets by 1.82, and again increased when the coefficient is calculated, when it is on account of the dividing line between the variation in the coefficient.

The length of head generally varies from 3.2 to 4.6 inches, while the number of spikelets vary from 15 to 21. With this information the data could be readily worked out. Table 3 gives the way the data is worked out and this table should be extended for the full table. Divide the number of spikelets by the length of the head in inches and multiply by 1.82. If answer is 8.26 to 8.75 take 8.5, if 8.76 to 9.25 take 9, and so on.

TABLE 2

To show difference between 4 selected heads and the total number of good heads on the plant.

Plant No.	4 SELECTED HEADS: Length of Head		Number of Spikelets		Spikelets per Inch	Spikelets × 1.82	Coeff. of Comp.	TOTAL NUMBER OF GOOD HEADS: No. of Heads	Length of Head		Number of Spikelets		Spikelets per Inch	Spikelets × 1.82	Coeff. of Comp.
1	3.625	3.6	80	20	5.56	10.12	10.	11	3.59	3.6	219	20	5.56	10.12	10
2	3.525	3.5	76	19	5.43	9.88	10.	10	3.50	3.5	189	19	5.43	9.88	10
3	3.9	3.9	83	21	5.39	9.81	10.	14	3.81	3.8	285	20	5.26	9.57	9
4	3.225	3.2	69	17	5.31	9.66	9.5	11	3.21	3.2	186	17	5.31	9.66	9
5	3.55	3.6	76	19	5.28	9.61	9.5	7	3.56	3.6	132	19	5.28	9.61	9
6	3.275	3.3	66	17	5.15	9.37	9.5	9	3.278	3.3	148	16	4.85	8.83	9
7	3.38	3.4	68	17	5.00	9.10	9.	13	3.29	3.3	218	17	5.15	9.37	9
8	4.275	4.3	84	21	4.88	8.88	9.	12	4.25	4.3	254	21	4.88	8.88	9
9	3.775	3.8	75	19	5.00	9.10	9.	8	3.737	3.7	151	19	5.14	9.35	9
10	3.6	3.6	66	17	4.72	8.59	8.5	11	3.48	3.5	182	17	4.86	8.85	9
11	3.888	3.9	71	18	4.62	8.41	8.5	7	3.87	3.9	124	18	4.62	8.41	8
12	3.975	4.0	75	19	4.75	8.65	8.5	10	3.91	3.9	118	19	4.87	8.86	9
13	3.575	3.6	67	17	4.72	8.59	8.5	15	3.5	3.5	246	17	4.86	8.85	9
14	3.925	3.9	70	18	4.62	8.41	8.5	8	3.875	3.9	141	18	4.62	8.41	8
15	4.225	4.2	80	20	4.76	8.66	8.5	14	4.17	4.2	279	20	4.76	8.66	8
16	3.975	4.0	69	17	4.25	7.74	7.5	16	3.93	3.9	274	17	4.36	7.94	8
17	3.95	4.0	69	17	4.25	7.74	7.5	15	4.00	4.0	259	17	4.25	7.74	7
18	3.875	3.9	65	16	4.10	7.46	7.5	12	3.90	3.9	195	16	4.10	7.46	7
19	4.03	4.0	63	16	4.00	7.28	7.5	8	4.03	4.0	127	16	4.00	7.28	7
20	4.38	4.4	68	17	3.86	7.03	7.	13	4.31	4.3	222	17	3.95	7.19	7

TABLE 3

Part of table for finding coefficient of compactness from length of head and number of spikelets.

No. of Spikelets	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	Length of head in inches.
	4.71	4.57	4.44	4.32	4.20	4.10	4.00	3.90	3.81	Number of spikelets per inch
16	8.57	8.32	8.08	7.86	7.64	7.46	7.28	7.10	6.93	Spikelets multiplied by 1.82
	8.5	8.5	8.	8.	7.5	7.5	7.5	7.	7.	Coefficient of compactness
	5.00	4.86	4.72	4.59	4.47	4.36	4.25	4.15	4.05	
17	9.10	8.85	8.59	8.35	8.14	7.94	7.74	7.55	7.37	
	9.	9.	8.5	8.5	8.	8.	7.5	7.5	7.5	
	5.29	5.14	5.00	4.86	4.74	4.62	4.50	4.39	4.29	
18	9.63	9.35	9.10	8.85	8.63	8.41	8.19	7.99	7.81	
	9.5	9.5	9.	9.	8.5	8.5	8.	8.	8.	
	5.59	5.43	5.28	5.14	5.00	4.87	4.75	4.63	4.52	
19	10.17	9.88	9.61	9.35	9.10	8.86	8.65	8.43	8.23	
	10.	10.	9.5	9.5	9.	9.	8.5	8.5	8.	

When the value of the head is taken by an imate it does not carry much weight when nparing two heads afterwards, but rather component parts, compactness, plump-s, number of spikelets and length of head, value are taken into consideration. Length head may be dropped when compactness is en by a mathematical calculation as it is d with the number of spikelets to get the npactness. But by using a mathematical cal-ation as far as possible that is still using estimation of plumpness, it will make the te for value comparatively correct and then value alone need be taken into account en comparing notes for different heads er.

The difficulty lies in getting a value to suit cases without too much overlapping. A mber of good heads were taken which uld be given a value for 10. Then the mpactness, and number of spikelets were en mathematically and the plumpness es-nated. As the compactness and plumpness creased the number of spikelets would de-ease taking the value to be remaining con-nt. A good head, one with a compactness 10 and a plumpness of 10 has on the aver-e 17 spikelets. This head would be given value of 10.

The value drops .5 for every spikelet less en the compactness and plumpness remain same. The value drops .5 for every point s for compactness when the plumpness and mber of spikelets remain the same. The lue drops .5 for every point less for plump-ss when the compactness and number of ikelets remain the same. The compact-ss and plumpness do not alter the value if ey only differ by .5 such as 8 and 8.5, and and 9.5.

This value note may be easily disagreed th but it gives true comparative value. is value is taken on four of the average od heads, just as the other head notes are.

In conclusion it may be said that this athematical calculation allows for faster rk, as all the notes taken are taken any-y, and at the same time it is more accurate d also less tiring.

Table 4

Part of table to find value from compactness, plumpness and number of spikelets.

Compactness	Plumpness	VALUE 11	10.5	10	9.5	9.	8.5	8	7.5	7.
8.5	10			19	18	17	16	15	14	13
	9.5				19	18	17	16	15	14
	9.				19	18	17	16	15	14
	8.5					19	18	17	16	15
	8.					19	18	17	16	15
	7.5						19	18	17	16
	7						19	18	17	16
9.5	10		19	18	17	16	15	14	13	12
	9.5			19	18	17	16	15	14	13
	9.			19	18	17	16	15	14	13
	8.5				19	18	17	16	15	14
	8.				19	18	17	16	15	14
	7.5					19	18	17	16	15
	7					19	18	17	16	15

Compactness	Plumpness	VALUE 11.	10.5	10	9.5	9.	8.5	8.	7.5	7.
9	10		19	18	17	16	15	14	13	12
	9.5			19	18	17	16	15	14	13
	9.			19	18	17	16	15	14	13
	8.5				19	18	17	16	15	14
	8.				19	18	17	16	15	14
	7.5					19	18	17	16	15
	7					19	18	17	16	15
10	10	19	18	17	16	15	14	13		
	9.5		19	18	17	16	15	14	13	
	9		19	18	17	16	15	14	13	
	8.5			19	18	17	16	15	14	13
	8.			19	18	17	16	15	14	13
	7.5				19	18	17	16	15	14
	7				19	18	17	16	15	14

Nitrate of Soda in the Apple Orchard.

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In no phase of agricultural work is keener interest in the fundamentals of plant nutrition shown by the practical farmer than in the orcharding business. Being, to a large extent at least, a one crop producer, the apple specialist requires and develops a clearer insight into the nature and uses of artificial fertilizers than many of his brethren following more diversified lines. For this reason we find orchardists of our large apple growing regions closely following and in some cases even preceding in their practices the work of scientific investigators. This tendency has been shown most notably in spraying and dusting work and to some extent also in the matter of fertilization. In support of this, the writer has in mind at least one thoughtful orchardist in Nova Scotia who discarded the liquid lime-sulphur spray after one year's use and returned to Bordeaux mixture several years before the plan became general or was even seriously considered by the experimenters in charge of orchard investigations. Moreover there are a few growers in the Valley at the present time who have been practising for years a satisfactory system of sod culture, while a careful study of the available literature on the subject fails to reveal any large amount of experimental data on the method.

The study of the cultural and fertilization problems of the apple orchard, in common with many other lines of agricultural investigation, has been largely confined to the last three decades. During this period knowledge has taken tremendous strides, and many ideas, which, to say the least, would have been considered revoluntionary ten years ago, are today becoming matters of common knowledge. There were, nevertheless, a few hardy pioneers in this work who seemed to grasp dimly the vastness of the problem, and who thus stand out conspicuously in a retrospective survey such as this.

Bailey (1) quotes A. J. Downing in "The Fruit Trees of America", 1st edition, 1845, as saying that trees should be manured as regularly as any other crop. But Bailey follows this with the statement that in general enough nitrogen can be supplied by cultivation and occasional cover crops, and that it seems easy to apply too much nitrogen. He safely suggests that on good soils that are well cultivated little nitrogen may be needed by young trees in the first three or four years of their growth.

Blair (2) in 1900 pointed out the importance of ample plant food and stated that nitrogen is lost most rapidly. If this were added solely in an artificial form, 125 lbs. of Nitrate of Soda per acre would probably be the minimum. He adds, "By far the cheapest way of securing nitrogen is by thorough tillage which increases or hastens nitrification and by green manuring. If these two latter methods are practised there will rarely ever be occasion to resort to commercial fertilizers." Leguminous crops were recommended.

Taft (3) in 1892 suggested in the absence of manure the application of a mixture of 50 lbs. of Nitrate of Soda, 200 lbs. of Bone Meal and 100 bu. of Wood Ashes, per acre. This he says is much too large for young trees unless applied broadcast to other crops, but in old bearing orchards this amount can be increased with profit. He adds that not over 100 lbs. of Nitrate of Soda are usually required.

Roberts (4) in 1895 presented the results of a twenty year experiment comparing the fertilizer requirements of wheat and apples commencing with the trees at 13 years of age. If the frequency with which this experiment has been quoted is a criterion, it may be considered somewhat of a classic. He found that with nitrogen at 15c, P_2O_5 at 7c, and K_2O at 4.5c per pound the fruit and leaves alone removed $87.00 worth more per acre of these substances than did an acre of wheat during the same period. He also found that compared with corn, nursery trees removed but a small amount.

Rane (5) in 1904 indicated the greater place artificial fertilizers were winning in experimental research when he stated that while not so good as manure on young trees in poor soil, they are useful in bearing orchards on rich soil.

Voorhees (6) in 1909 went a step further in stating that organic nitrogen is less readily available and more expensive than either nitrate or ammoniacal nitrogen. This may be taken as pointing the way to the many subsequent investigations into the uses and application of Nitrate of Soda in orchard practice.

Stewart (7) in 1913 reports experiments with nitrogen fertilizers composed of half Nitrate of Soda and half Dried Blood, in combination with other fertilizers. In no case was nitrogen used alone but in every plot where it was used there was a great increase in trunk girth over that recorded for mixtures from which it was omitted.

Lewis and Allan (8) in 1914 endeavoured to confirm the work of others as to whether Nitrate of Soda sprayed on the foliage had the same effect as when applied to the soil. In the spray the Nitrate of Soda was mixed with Caustic Soda. No increase in yield was observed from the spraying method and considerable bud injury was reported. In three years' experiments on 16 year old Spitzenbergs Nitrate of Soda at the rate of 5.6 lbs. per tree, spread on the ground under the tree, restored vigor and fruitfulness. In storage tests there was little difference in the keeping quality between fruit from fertilized and unfertilized trees. They state that nitrogen was the only element which gave noticeable returns and for best results should be applied before blossoming.

Ballow (9) (10) in experiments over a period of five years took as his basis of fertilization 5 lbs. of Nitrate of Soda, 5 lbs. of Acid Phosphate and 2½ lbs. of Muriate of Potash per tree, applying them in orchard renovation. Yield and vigor were both restored. He says, "The wonderful results coming so promptly, are due largely to nitrogen." Of the results described in the first bulletin, in two orchards out of three the average yield per tree was slightly higher where Nitrate of Soda was used alone than where the other ingredients were added. In the third case Bone Meal was used instead of the Acid Phosphate. A late spring frost in 1910 did severe injury to the poorly fed trees but little to those well fed.

Over a five year period a wonderful change in productiveness was evident in the Nitrate of Soda plots. Little benefit was shown from the addition of either Acid Phosphate or Muriate of Potash in the tree growth, yield, appearance or texture of fruit. These results were similar at three different locations. Where Tankage and Bone Meal were substituted for the Nitrate of Soda and Acid Phosphate in the last year of the five, the plots dropped back to about one-half the increase over the checks which they had averaged in the first four years of the test. The only point recorded definitely in favor of the Acid Phosphate was in its effect on the growth of clover in the orchard.

Moore (11) in 1916 seems to crystallize the situation for all the investigations up to that time by stating that on ordinary soils no fertilizer is needed up to the bearing age unless other crops are grown. He considers with the average grower, applications of nitrogenous fertilizer, incorporation of vegetable matter and tilth are the operations of most concern. And, "More often than is usually thought nitrogen is the limiting factor in fruit production". He warns, however, that too great amounts produce excess of wood growth and decrease the color of the fruit.

More recent reports, (12) (13) (14) (15), tend to establish the soundness of the opinions of Moore mentioned in the preceding paragraph.

The consideration of the inter-relation of growth and fruitfulness has opened a still more intensive study of the effect of nitrogenous fertilizers. Kraus and Kraybill (16) and Kraus (17) working on tomatoes have obtained some highly significant results Paragraph 21 of their summary reads:—"Fertilizers containing available nitrogen or that which may be made available are mainly effective in producing vegetative response. They may either increase or decrease fruitfulness *according to the available carbohydrate supply.*" And Par. 22:—"Irrigation or moisture supply is effective in increasing growth or fruitfulness only when accompanied by an available nitrogen supply and vice versa. The effectiveness of leguminous cover

crops is dependent upon the accompanying moisture supply."

Work (18) reporting somewhat similar tests states in his summary, paragraph 5:—"It was not found possible under these conditions (i.e. of his own test) to induce a condition of heavy vegetation and unfruitfulness by means of large applications of Nitrate of Soda". His test included applications of Nitrate of Soda as high as 18,048 lbs. per acre to quartz sand. Par. 6:—"There is evidence in support of the hypothesis that the injurious influences of the higher applications of Nitrate of Soda are due to its effect as a factor in the environment of the plant, reducing the availability of the water supplied rather than through its effect as an internal poison." Par. 10.—"The relation between nitrogen content and fruit making is similar to that between nitrogen and vegetative growth and the evidence in that regard is nearly as conclusive." Par. 12:—"There is no apparent relation between the amount of nitrogen applied to the soil and the concentration of total carbohydrates in the plants save that the latter is high in those plants whose growth has been stopped by lack of available nitrogen." Par. 15:—"There is no indication that either high or low carbohydrate content inhibited either vegetative or reproductive growth of the plants in these experiments."

The effect of Nitrate of Soda on biennial bearing of apples is mentioned by Roberts (25), Crow (19) and Crow and Eidt (20). Crow states:—"Our experiments show that annual bearing can be induced by stimulating growth with Nitrate of Soda early in the spring of the off year." This experience has been confirmed by the present writer on a three acre block of mature Baldwin trees.

A possible sidelight on the methods of fertilizer application is provided by Auchter (21) who found that when Nitrate of Soda was applied to one side of a tree only each side acted independently. The leaves of the untreated sides in all cases lost nitrogen. These check halves behaved much the same as full check trees and the treated halves acted much as fully treated trees. When the roots were entirely removed from one side and Nitrate of Soda applied all around, only that side on which the roots were left obtained nitrogen. Water, on the other hand, was found equally in the leaves of both sides.

At the present time, attention of farmers and investigators alike is being turned to the possibility of carrying on orcharding successfully under sod conditions. Russell (22) cites experiments at Woburn showing that the effect of growing grass around apple trees is to arrest all healthy growth. The leaves become unhealthy and light colored, while the fruit loses its green color and becomes waxy yellow or brilliant red. Where grassing was done gradually the trees accommodated themselves somewhat to the altered conditions but never grew so well as when grass was absent. "The only explanation appears to be that a toxin is excreted by the grass". However it was impossible to find any traces of this toxin by laboratory test.

This description by Russell of the so called toxic effects of grass is typical of trees deprived of nitrogen in an available form, the necessity of which is frequently stressed by the authorities previously cited. If it were possible for a toxin in the soil to change the color of the fruit from a green to a waxy yellow or a brilliant red, one wonders how many growers or consumers would object to its presence! Doryland (23) presents data to show that nitrates are reduced in the soil to other forms of nitrogen without loss as proven by analyses of total nitrogen content. May not the Woburn situation have been due to this fact, and may not the thrifty conditions maintained in the sod orchards mentioned in the introduction to this article, be due to their receiving regular applications of Nitrate of Soda?

Collison and Harlan (24) in 1923 add something still further to the question of orchard experimentation. In this bulletin an attempt to analyze data by modern statistical methods has been made. They state in part:—"The most consistent results have been obtained with the cherry orchard where it seems certain that nitrogen has increased the growth of trees. This is not true however of fruit yields in the same orchard. In the three apple orchards neither growth nor yields have been consistently affected by fertilizers. All the apple orchards present about the same lack of clear cut and definite response to fertilizer treatment." This apparent fail-

ure to obtain results is explained by them as probably due to small random samples being taken to represent a large population in which the variability is naturally high. They suggest the advisability of using larger numbers of more uniform trees, more replications and a better system of control plots. They conclude that greater knowledge of tree nutrition is needed before orchard experimentation of real value can be carried out. What effect this method of interpreting results might have had on many of the previous experiments cited would be interesting to know.

The Present Status of Nitrate of Soda

1. That Nitrate of Soda has given marvelous results in restoring vigor and fruitfulness to neglected, run down orchards, seems certain.

2. Used in reasonable quantities, Nitrate of Soda is a safe and satisfactory source of nitrogen for general orchard use.

3. Nitrate of Soda is useful in promoting annual bearing.

4. Nitrate of Soda is the most important and in some cases possibly the only fertilizer required by the orchard.

5. An excess of nitrogen may possibly promote vegetativeness at the expense of fruitfulness in orchard work but this point is yet to be proven.

6. More extensive experiments in orchard fertilization, especially with regard to nitrogen, are needed.

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Dominion Department of Agriculture Notes.

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EXPERIMENTAL FARMS BRANCH

Field Husbandry Division

Mr. L. B. Thomson, B.S.A. (Alberta) has been recently appointed to the staff of the Field Husbandry Division of the Dominion Experimental Farm System. He will undertake experimental work in Alberta and Saskatchewan to improve the carrying capacity of range land. Mr. Thomson is a native of New Zealand and has had experience in ranching both in that country and in Canada. E.S.H.

Bee Division

Honey Production in the Western Provinces

Beekeeping in the three prairie provinces of western Canada is attracting considerable attention at the present time, due to the phenomenal increase in honey production during the past few years. Since 1921 the crop produced in Manitoba has increased from less than one million pounds to over four millions in 1925. In Saskatchewan the proportional increase has been much larger during the same period but less bees are yet kept than in Manitoba. The increased acreage of Sweet Clover is responsible for the increase in the two provinces. In Alberta similar progress has been made, especially in the irrigated areas of the southern part of the province. One beekeeper alone near Lethbridge starting in the spring of 1924, increased his apiaries to 600 colonies in 1925 and produced at least as much honey as reported for the whole province in the previous year. During the latter part of January and early in February, the writer attended several short courses and conventions on beekeeping held in the three provinces and was much impressed at the enthusiasm displayed in this branch of Agriculture. C.B.G.

Animal Husbandry Division

Record Breakers

One World's and two Canadian Ayrshire records have been made at the Experimental Station, Ste. Anne de la Pocatière, Quebec, under Canadian Record of Performance rules, within the last six months. They are as follows:

Briery Lass —85707—, World's record Ayrshire butter fat producer, with a record of 22,035 pounds of milk and 979 pounds of fat in 365 days, being 23 pounds more fat than the former United States record holder and 78 pounds more fat than the former Canadian champion.

Beaver Meadow Beauty 6th —74584—, Canadian record four year old in the 305 day division, with 16,051 pounds milk and 70 pounds fat, being 3,041 pounds more milk and 125 pounds more fat than the former title holder.

Primrose —78274—, Canadian and living World's Champion three year old, with a record of 17,406 pounds milk and 746 pounds fat in 365 days, being 9.8 pounds more fat than the former living United States title holder and 2,394 pounds more milk and 86 pounds more fat than the former Canadian record. G.B.R.

Cereal Division

Bread Making Qualities of Garnet Wheat

During the past two years the bread making qualities of the promising new wheat variety called *Garnet* have been very extensively and thoroughly investigated by the Cereal Division and also by independent institutions. Five pound samples both of Garnet and of the standard variety Marquis, were obtained for comparison from the crops of 1924 and 1925 grown at the Federal Experimental Farms in the three Prairie Provinces. A sample of these two varieties was also sent for a comparative test to the O.A.C., Guelph, to the Western Canada Flour Mills, Winnipeg, and to the Ogilvie Milling Co., Montreal. In addition to these tests, which of necessity had to be confined to relatively small quantities, 100 bushels each of Garnet and Marquis were shipped from the Experimental Farm Scott, Sask. to the State Testing Mill at Minneapolis, Minn., for comparing on a commercial scale. The Pillsbury Milling Co. of Minneapolis also obtained 12 bushels of each variety from this shipment.

Space will not permit more than a very brief discussion of these investigations here

A fuller statement of the results obtained will appear in the next annual report of the Cereal Division.

It is interesting to note first of all how closely the results obtained by the different investigators agree. A careful analysis of these results seems to indicate that there is very little difference between Marquis and Garnet in bread making qualities except in the matter of colour. In this respect Marquis produces a little whiter flour and crumb than does Garnet, although the latter in turn seems to excel in colour such varieties as Kota.

L.H.N.

Poultry Division

The World's Poultry Congress will be held at Ottawa, July 27th to August 4th, 1927. The selection of Canada for this World's Poultry Congree is a marked tribute to the prominence which this Dominion has attained among the nations of the world.

The World's Poultry Congress Preliminary Announcement has just been issued from headquarters at Ottawa. The members of the C.S.T.A. have been mailed copies of this Announcement. They should be interested in many of the problems which will be discussed at the Congress, particularly those on breeding. There should be a large delegation of technical agriculturists at the World's Poultry Congress to assist in welcoming the many prominent scientists who will come from Great Britain, the United States, and many European countries.

The Canadian poultry exhibit at the World's Poultry Congress held at Barcelona, Spain in 1924, was very outstanding, and very favourably commented upon by the delegates from other countries. Canadian poultry was also shown at Wembley in 1924 and 1925 and as a result of this orders for registered and Record of Performance stock are now being received by Canadian breeders.

The first official record of the sale for export of a registered cockerel comes from the Experimental Farm, Nappan, N.S. A trio of registered Barred Plymouth Rocks was shipped last month to Holland. It is perhaps fitting that this export sale should have been made by the Dominion Department of Agriculture. This Department has constantly taken the lead in the matter of registration of poultry and the medium through which registration can be obtained, namely, the Canadian National Egg Laying Contests are all conducted on Dominion Experimental Farms.

One of the outstanding live poultry exhibits at the World's Poultry Congress in 1927 will be that of the Canadian National Poultry Record Association, the organization through which the registration of poultry is conducted.

Canada welcomes comparisons in egg production. In the recently issued international poultry Blue Book a report is given of the results from 66 Egg Laying Contests conducted in 14 different countries. Of the 30,325 birds entered in these contests 31 birds passed the 300 mark, and of these 31 Canada had 14. These included the highest with 332 eggs and the second highest with 331 eggs. The highest bird, a White Leghorn, was bred by the Experimental Farm at Agassiz, B.C.

The International Poultry Blue Book was compiled by Mr. W. E. Robinson of Springfield, Illinois, and the following appears in the foreword. "To make Egg Laying Contests valuable there must be opportunity for intelligent comparison. This can be accomplished only by standardization. Canada has set the pace and it is hoped that all countries will fall in line."

Tobacco Division

It is with genuine regret that we record the resignation of Mr. D. D. Digges, Superintendent of the Experimental Station at Harrow, Ont., to accept a position with the Imperial Tobacco Co., of Canada. Mr. Digges has been a member of the Tobacco Division of the Experimental Farms System continuously since 1915, during which period he has won esteem among his associates by his sunny disposition, integrity, energy and efficiency. The Imperial Tobacco Company is to be congratulated upon this addition to their staff, and we desire to extend to Mr. Digges in his new position the best wishes of his former coworkers.

Mr. H. A. Freeman, M.S.A., (Wis.) Tobacco Specialist, who has also been with the Division since 1915, has been promoted to

the position of Superintendent at Harrow. He brings to his new position a wide experience with tobacco both from the cultural and marketing viewpoints. In addition, he is particularly well acquainted with the southwestern Ontario tobacco growing district.

Recent technical publications from the Tobacco Division include two articles in the February and April issues of *Scientific Agriculture*: "New and Unusual Diseases and Injuries of Tobacco" by C. M. Slagg, and "Soil Treatments with Various Disinfectants" by T. G. Major. C.M.S.

LIVE STOCK BRANCH

A pamphlet which will be issued shortly by the Poultry Division of the Live Stock Branch deals with a method for paying producers for their eggs according to grade in instances where the country storekeeper who receives their eggs is not equipped to do candling and grading. In the pamphlet a method is outlined whereby such country shippers may mark a producer's eggs in a case and the grading of these separate lots will be determined by the wholesale dealer to whom the eggs are shipped.

To bring about an improvement of quality in any farm product the farmer must be paid for that product on a quality basis. This principle has been adopted in the marketing of many Canadian farm crops and is in no small degree responsible for the high standard which these crops have attained both at home and in foreign markets.

The actual grading of any farm product must naturally be done not on the farm but at the warehouse or factory to which the product is delivered, since at such places equipment and adequate inspection to insure proper grading are more readily available than on the farm itself.

With some products grading is more easily accomplished than with others. Crops which are produced on a specialized farm and which are as a result shipped in large quantities direct to receiving stations designed especially to handle that product are more readily graded than products grown merely as a side line. In the latter instance such products may be marketed not direct to the trade which is especially equipped to handle and grade it but to country shippers who are not so equipped.

Perhaps no other farm product comes so largely in this latter classification as eggs. The majority of the eggs in the country are produced as a side line on farms and marketed through the country stores. The country stores are not always capable of grading the eggs and if farmers are to be paid for their eggs according to quality some means of grading must be furnished.

The pamphlet referred to above is designed to meet this need. The country storekeeper on receiving the producer's eggs packs them in the case in a definite order, wrapping the last egg packed with a slip from a counter check book on which is given the producer's name and the quantity of eggs in his lot. A candler in the warehouse of the wholesale dealer who receives the eggs will on opening the case be able at once to identify each producer's eggs.

Methods of a similar nature have been tried in the past but they have had the drawback of requiring a candler to do too much accounting in making up each individual's grading. Under the method given in this pamphlet this difficulty is overcome. A candler is not required to compute each producer's grading but is supplied with a special form on which he marks down, as he has graded each producer's lot, the number of graded eggs in each case into which he has graded. With this information on the form the grading of each farmer's eggs can be readily made up either in the office of the wholesale dealer or by the country shipper.

The plan is simple—a candler has on his bench before him the case of eggs which he is candling, on either side he has a case of extras, firsts, seconds and cracks into which he places the eggs of the various grades as they are candled out. When he has finished one producer's lot he marks the number of extras, firsts, seconds and cracks in the respective cases. After he has finished the second producer's lot he again marks down the eggs in his various cases. This procedure is continued with the candler being required to do no other figuring than merely marking down his bench count.

The simplicity of the method should bring about a much wider adoption of the princi

ple of graded payments for eggs. The pamphlet referred to will be off the press shortly and all technical agriculturists, whose work brings them in touch with poultry production and egg marketing should make themselves acquainted with the workings of the plan.

H.S.A.

DAIRY AND COLD STORAGE BRANCH

The Dairy and Cold Storage Branch took over on April 1st, 1926, from the Provincial Department of Agriculture, grading of butter in the Province of Saskatchewan. Messrs. H. J. Crowe of Regina and S. P. Broby of Saskatoon, who have been for some years on the staff of the Provincial Department of Agriculture as graders of butter, have been appointed in a similar capacity to the staff of the Dairy and Cold Storage Branch. An appointment of a second grader at Saskatoon will be made shortly.

Owing to the increased volume of dairy produce being offered for grading at Toronto, it has become necessary to have a second grader at that point and Mr. Jas. H. Henderson of the Montreal staff has been transferred to Toronto. The vacancy at Montreal, caused by the transfer of Mr. Henderson to Toronto, has been filled by the appointment of Mr. Jos. Lefebvre of Point Rouge, Que.

During the season of 1925, the Research Division made analyses of several hundred samples of Canadian Cheddar cheese with the object of determining the average composition of highest grade cheese at different seasons of the year and also with the object of determining the influence of characteristic defects on the composition. This work will be continued during the coming season.

J.A.R.

SEED BRANCH

Browntop Seed Supply

Browntop, Rhode Island Bent, and Colonial Bent are different names for the same grass, according to the country of origin. Browntop seed production is being encouraged in our Maritime Provinces and 20,000 pounds were marketed this season. The New England states formerly produced Rhode Island Bent seed in quantity, but very little during recent years. The Browntop or Colonial Bent of New Zealand has been in demand in both the United States and Canada, also the German Bent which is composed largely of Browntop some Redtop and very small percentages of the Creeping and Velvet Bents.

With the rapid increase in the number of golf courses, recreation grounds and fine lawns there is a large demand for turf grass seeds. The United States imported last year about three million pounds and Canada a half million. The Browntop supplies have been high in price and are in special demand for putting greens, particularly in Canada and the northern half of the United States. Price of seed is perhaps a secondary consideration provided genuineness of variety, quality of stocks, and freedom from bad turf weeds can be assured.

German Mixed Bent is sometimes diluted with Redtop, and very few lots will grade above No. 3 under our Seeds Act. Both the German and Colonial Bents are usually high in chaff, dust, or other inert matter, and are sometimes foul with weed seeds. These expensive turf grass seeds should always be purchased on Canadian seed grades, and No. 1 is the cheapest for putting greens when the cost of hand weeding is considered.

The different varieties of bent grass seeds can be distinguished only by an expert with the aid of the microscope, and Redtop seed cannot be distinguished from that of Creeping Bent. If grown together the varieties will cross and produce hybrids of doubtful value. The growing seed crops can, however, be inspected in the field and certified as to purity of variety. There are well marked differences in root system, leaf blade, ligule, and flowering head when the varieties are grown separately without natural crossing.

In developing our Browntop seed industry careful attention has been given to all these factors. Very little Redtop has been sown in the Maritime Provinces and only in certain districts. When the off-type plants exceed ten per cent of the crop a field is not certified as Browntop but might be sold as a Browntop Mixture.

A Dominion Seed Inspector examines each field of Browntop primarily for purity of variety and weed content. If the purity is ninety per cent or over and the weeds are of a kind so that the seed can be cleaned to

grade, the field is certified accordingly. The report of inspection includes size and position of field, year of seeding and kinds of seed used, estimated yield of Browntop seed, etc., and the grower in submitting his seed to the Cleaning Plant is required to make a declaration that it is from the field so inspected. The field inspection and the official sealing in the sack under the seed grade is a guarantee to the purchaser which is not provided with imported stocks.

The cleaning of Browntop is a slow and tedious process. Special machinery with finely-adjusted air blast is required, and the expensive screens, both woven wire and perforated, soon wear out from the friction of fine sand and soil particles. The latter are removed by a screen with seventy meshes to the inch, and the seed is so small that some of it is wasted in the operation. Some lots of Prince Edward Island Browntop have been cleaned this season to ninety-six per cent of pure seed, and the germination usually runs over ninety per cent.

The principal turf weeds which give trouble in cleaning are ox-eye daisy, plantain, field chickweed, yarrow or wild tansy. Practically all the daisy are held on the upper screens, and laboratory tests have proven that very few of those which pass these screens will germinate. The plantain and chickweed are more difficult of separation, and many fields are turned down on this account. High cutting of the seed crop is recommended to escape these bottom weeds, and it is hoped that a header may be found suitable for harvesting.

Dr. F. T. Shutt, Dominion Chemist, is co-operating with the Seed Branch by making analyses of Browntop soils and planning fertilizer experiments to encourage seed growth. This grass flourishes on a soil ranging from sandy loam to clay loam, and the samples examined are rather poor in fertility. They are all strongly acid which does not favour clover and the agricultural grasses.

In the general farming practice of the Maritime Provinces this type of soil if seeded down to clover and timothy will soon revert to Browntop, which appears naturally as a volunteer crop. As the fertility becomes too low other natural grasses and weeds gradually displace the Browntop and the meadow becomes useless for seed production.

The fertilizer experiments of last year indicate the value of ammonium sulphate, and this result is in keeping with that obtained by the U. S. Department of Agriculture at the Arlington turf gardens. It is probable that superphosphate and muriate of potash are also required for a maximum seed crop which is an additional consideration to the production of turf. It is our intention to have larger areas treated this season, and the seed from each will be harvested separately for comparison of yield and quality.

The growers are being advised to break up their fields which have passed the Browntop stage, cultivate thoroughly for destruction of weeds, apply commercial fertilizers, and sow Browntop with a nurse crop of oats. It may take a couple of years to produce a seed crop, but the demand for seed will be increasing and permanent. United States dealers have purchased some of the Maritime seed but most of it was reserved for the Canadian trade.

It is evident that the price of Browntop seed must necessarily remain high. The yield per acre in 1925 averaged only forty pounds and only sixty-two per cent of the total graded No. 1. The costs of production, centralizing, cleaning and marketing are borne by the growers, and they must be assured of fair profits to continue in the business. The dealers pay for seed, sacks, transportation, storage and distribution, and should have a reasonable return for the money invested and to cover the services rendered.

G.LeL.

La Revue Agronomique Canadienne

RÉDACTEUR—H. M. NAGANT

Les Caractères Héréditaires.

Leur nature, leur valeur

P. M. LOUIS-MARIE, O.C.

Professeur de Botanique et de Génitique à l'Institut Agricole d'Oka

(suite)

10—Base physique de l'hérédité

Il est un endroit, dans le cycle vital, où facilement nous pouvons, ce semble, saisir le lieu réservé au siège de l'hérédité. Le pont qui sépare en effet, deux générations consécutives est très étroit.

D'où vient le germe qui déjà contient la somme des caractères héréditaires? De la fusion d'un spermatozoide et d'un ovum, d'un grain de pollen et d'un ovule.

Nécessité par conséquent de posséder pour poursuivre intelligemment l'étude de l'hérédité améliorante, quelques principes de cytologie et de physiologie; 1—savoir ce que sont les cellules du corps et celles du germe; 2—savoir encore comment se forment les gamètes; 3—savoir enfin comment ces gamètes se fusionnent et ce qui en résulte.

Ces notions étant trop élémentaires pour n'être pas familières, disons brièvement comment tous les savants, ne donnant pas à la cellule et à chacune de ces parties la même valeur, furent amenés à placer diversement et en divers lieux le substratum héréditaire. On ne considère plus aujourd'hui le cellule comme une unité de vie, mais bien plutôt comme un microcosme; un monde infiniment petit par rapport à nous, infiniment grand par rapport à ces infimes corpuscules qui l'habitent.

1. Une première école (J. Loeb, Etienne Rabaud, Dr Roux) prétend que le siège de cette grande manifestation de vie qu'est l'hérédité, réside dans l'organisme vivant tout entier, sans qu'il nous soit possible de le localiser en un point déterminé; l'hérédité est le jeu d'ensemble des organes, tissus et cellules. Pour eux le caractère ou unité héréditaire déborde la cellule. Tels sont les Organicistes.

2. Quelques savants, disons "l'école chimiste", localisent le siège des changements héréditaires sur l'atôme, la molécule; tels, parmi les récents:

a) *M. Armand Gautier,* dans sa théorie de la "Coalescence des plasmas". De nombreux mendélistes à tendances matérialistes, expliqueraient volontiers par la présente théorie ou par la suivante, l'instabilité momentanée de certains caractères héréditaires;

b) *M. Auguste Lumière,* qui sans être génétiste, émet dans sa "Théorie de la floculation des micelles" des principes dont on se sert déjà pour expliquer les rares dérangements des variations. "Remarquons maintenant, dit M. Auguste Lumière, que les tissus et les humeurs de tous les êtres vivants sont essentiellement constitués par des colloides: les protoplasmes et les noyaux cellulaires de tous les organes, ainsi que les liquides qui les imprègnent sont des matières albuminoïdes à l'état colloidal. La vie n'est pas possible en dehors de cette structure particulière de la matière, et quand cette architecture se trouve détruite par la floculation, des troubles surgissent en relation avec l'importance et la nature des éléments floculés....."

3. Une troisième école, immense, contenant la presque totalité des savants américains, anglais, allemands d'aujourd'hui et une grande partie des autres biologistes européens, place

quelque part le siège de l'hérédité. On les a englobés sous le nom générique de *Microméristes.* Les premiers d'entre eux furent des spéculateurs supposant: a/ des unités physiologiques, intermédiaires entre la cellule et la molécule, comme substratum héréditaire (Brucke, Spencer) b/ des unités morphologiques; plastidules, gemmules.... pangènes, biophores, déterminants, ids, idantes, etc. (Owen, Haeckel, Jager, Brooks, Galton, Nusbaum, Darwin, Weismann....) Les plus récents se servirent des découvertes de la cytologie pour contrôler la nature et le lieu du siège de l'hérédité. Dès 1839, Schleiden et Schwann avaient formulé la "Théorie cellulaire"; cependant ce n'est que vers 1875 que les brillants travaux de Butschli, Fol, Strasburger, Fleming, Carnoy, Van Beneden révélèrent le mécanisme des divisions équationn elles (mitoses), et réductionnelles (meïoses) Les chromosomes, ou segments de chromatin contenus dans le noyau, furent mis à l'ordr du jour, peut-être plus que séant, et y son demeurés. On plaça sur eux, non sans quelqu raison, la base physique de l'hérédité: le chro momère, unité physiologique, devint le sièg des caractères. Des éléments des gamète mâle et femelle comme de ceux des cellule du corps, la chromatine, en grains isolés o associée en chromosomes, est le seul qui soi stable. Constatation très importante: le nom bre des chromosomes est spécifique; dès qu ce nombre varie, apparaissent des anomalies des monstruosités. Voici quelques nombre spécifiques de chromosomes:

Liste de quelques nombres chromosomiens (d'après Wilson, Painter, etc.)

Espèces	Nombres (1) Haploides	Diploides
Animaux		
Ascaris (Ver)	1-2	2-4
Cyclops (parasite)	2	4
Anopheles (maringoin)	3	6
Drosophila (Drosophile)	4	8
Musca (mouche ordinaire)	6	12
Columbia (pigeon)	8	16
Salamandra (Salamandre)	12	24
Lepus (lapin)	22	44
Homo (l'homme)	24	48
Equus (le Cheval)	30	60
Cambarus (poisson)	100	200
Plantes		
Pisum (pois)	7	14
Triticum monococcum (blé monococcum)	7	14
Triticum durum (blé dur)	14	28
Triticum vulgare (blé ordinaire)	21	42
Spirogira (algue verte)	12	24
Sphagnum (Sphaigne)	20	40
Pinus (le pin)	12	24
Allium cepa (oignon)	8	16
Lilium (lis)	12	24
Fucus (algue)	32	64
Dryopteris (fougère)	72	144

(1) Les cellules germinales (pollen, ovule....) ont un nombre haploide de chromosomes, les cellules somatiques ont un nombre diploide de chromosomes.

Règle générale, la fécondation n'est possible qu'entre individus de même espèce, ou d'espèces très voisines, c'est-à-dire entre individus ayant un même nombre de chromosomes ou deux nombres, multiples l'un de l'autre.

11—Drosophila Melanogaster

Qui pourra dire quel pas de géant a fait faire à la Biologie cette petite mouche, dont le noyau des cellules reproductrices ne compte que quatre chromosomes. Elle constitue un matériel de laboratoire excellent, donnant, une génération en moins de deux semaines; matériel peu encombrant, 100.000 individus se logent facilement dans quelques bouteilles. C'est par centaines, par milliers qu'il faut compter, sur ce petit insecte, les caractères se prêtant à l'étude. Fait significatif, en faveur de la théorie chromosomienne: cette multitude de notes n'évolue que par compagnies, que par régiments, il y a une corrélation facile à controler. Nous voici en présence d'un nouveau genre d'hérédité corrélative, cette fois bel et bien authentique. Impossible en effet, de séparer les caractères ainsi liés par combinaisons mendéliennes. Tels sont, par exemple, les caractères: corps gris—oeil rouge—ailes longues (dominants) et corps jaune—oeil blanc—ailes courtes, (récessifs).

Cette liaison s'impose, avons-nous dit, pour tous ceux qui localisent le siège de l'hérédité sur les chromosomes. Ces segments de chromatine sont en nombre très limité; la moyenne pour les cellules reproductrices des végétaux est de 10 à 20. Pour le règne animal, la moyenne est sensiblement plus forte. *Bateson et Punnett* (1906) découvrent, chez le pois d'odeur, la "liaison" (qu'ils nomment gameting coupling) des caractères: fleur pourpre—pollen long et fleur rouge—pollen sphérique.

Emerson (1911) découvre la liaison pour le blé d'Inde.

Collins nous offre un exemple typique de cette corrélation dans son croisement de maïs à endosperme pourpre-amidon et blanc — ciréux.

A *T. Morgan* et à son école, recherchant des cas de mutation chez notre Drosophile, nous devons en pratique l'entier concept de la liaison qui existe entre certains facteurs. Chez cette mouche, les caractères, qui se comptent par centaines, se séparent et passent d'une génération à l'autre en quatre groupes. La cytologie a reconnu qu'il n'y a que quatre chromosomes dans la cellule de Drosophila. L'oeil du microscope, en fouillant bien, a trouvé que ces 4 chromosomes n'avaient pas la même longueur, mais que trois étaient longs et un très court. L'étude microscopique des formes héréditaires du corps et des membres de cet insecte, qui a révélé la présence d'une corrélation héréditaire, a constaté d'une façon parallèle, à côté de trois grandes associations de caractères, une quatrième ne comptant que deux notes. Voici quelles sont les mesures comparées des trois longs chromosomes: 112- 159- 159- et du quatrième: 12- Le spermatozoide et l'ovum, lors de la fécondation, fusionnent leurs noyaux; l'oeuf, une fois fécondé, se transforme en embryon et donne naissance à toutes les cellules somatiques qui portent quatre paires de chromosomes, quatre paires d'allélomorphes, c'est-à-dire, paires dont les deux membres sont identiques de formes.- Chez Drosophile pourtant, une de ces quatre paires d'allélomorphes, -celle qui porte le sexe,- fait exception; un des segments est porteur du sexe féminin et droit, on l'appelle le chromosome X; l'autre, porteur du sexe masculin est recourbé, c'est le chromosome Y. La présence ou l'absense de XY peut donc être controlée au microscope. Or, chose très frappante, quand le chromosome X est absent, l'individu qui naît est toujours un mâle; lorsque c'est le chromosome Y qui fait défaut, l'individu appartient au sexe féminin! Cette question de sexe est très complexe et encore aujourd'hui controversée. Tous les manuels la traitent au long. Je vous renvoie particulièrement au récent article de Sharp, page 195, ler Vol. jubilaire de Grégoire. Ce qu'il y a de certain, c'est que la répartition des sexes échappe encore à notre contrôle, et c'est une bénédiction en Eugénique (Génétique appliquée à l'espèce humaine.)

Dans l'amélioration du bétail, le contrôle du sexe serait pourtant d'une extrême conséquence; et le problème, nous l'espérons, trouvera sa clef avant longtemps, voici comment. Chez les bovidés, le nombre des

chromosomes de l'ovule est de dix; le sperme du taureau contient des spermatozoides de deux sortes: les uns de 10 chromosomes, et les autres de 9. Les gamètes mâles renfermant par ailleurs très peu de protoplasme, une différence d'un chromosome à l'intérieur du noyau, détermine une différence dans les dimensions. Si ce dixième chromosome est un tant soit peu volumineux, le gamète mâle, porteur de 9 chromosomes seulement n'aura que les 9/10, peut-être que les 4/5 du volume du spermatozoide ayant 10 chromosomes. Pareille différence de taille se remarque au microscope. Il nous reste donc à trouver l'appareil qui rapidement, pourra faire le triage entre ces gros et petits spermatozoïdes; ensuite par fécondation artificielle, nous pourrions automatiquement avoir des femelles à volonté. Le difficile est de réaliser un filtre ayant cette sensibilité requise. Je crois plutôt que ce triage s'opèrera par des agents physiques ou chimiques:- chaleur, froid, lumière, eau, solutions chimiques diluées—dont l'action neutralisera les spermatozoïdes, par exemple, de 9 chromosomes, c'est-à-dire plus faibles en chromatine. On nous promet une solution d'ici à dix ans. Ce qu'il y a de patent, c'est que le contrôle du sexe n'est pas impossible. Nous ne connaissons pas complètement sa nature; il y a peut-être plus qu'une simple affaire de chromosomes.

Aujourd'hui il est certain que les caractères secondaires du sexe se différencient sous l'action des hormones. Le caractère héréditaire sexuel consiste en une force, qui, opérant au centre des gonades durant les stages embryonnaires, oriente la sécrétion et en fait sortir des hormones mâles ou femelles. Rien ne prouve que cette force ne soit pas en rapport direct avec l'appareil chrómosomien.

Un 6ème type de caractère héréditaire dont nous pouvons maintenant dire un mot, puisqu'il n'est en réalité qu'un sous-type de l'hérédité corrélative ou "liaison", est celui des allélomorphes multiples. Les caractères héréditaires se comportent comme s'ils étaient situés sur le ruban de chromatine. Le cytologie a entrepris de fouiller à fond ce formidable laboratoire de vie qu'est la cellule; or, dans ce que nous appelons chromosome, elle distingue: un ruban de linine qui n'a pas les mêmes affinités tinctoriales (hématoxyline Delafeld, vert de méthyle ...) et qui probablement ne joue qu'un rôle de soutien. Il n'est pas demontré que ce ruban soit plat; au contraire, il semble que nous ayons affaire à un cordon cylindrique, le long duquel s'égrènent comme au hasard les chromomères, qui eux, sont de chromatine. La distance entre deux grains consécutifs est souvent très faible. Lorsque le cordon de linine est volumineux, il peut se faire que plusieurs grains soient localisés côte à côte sur un même plan transversal du chromosome.

Ces découvertes arrivent à point pour donner droit d'existence à notre sixième type de caractère relevant "d'allélomorphes multiples".

1. Cuénot, Morgan, Sturtevant, Little, montrèrent qu'en un seul lieu (chromomère) du siège de hérédité de certaines souris, trois pigments—chocolat, jaune et noir,—se trouvent superposés.
2. Emerson a démontré que chez le maïs balle, stigmates et graines blancs n'ont qu'un lieu.
3. Nabours a découvert une série de formes existant de la même façon chez Paratillix (sauterelle).
4. Morgan obtint d'une seule paire de chromomères homologues, c-à-d. situés au même point d'un chromosome somatique la suite de couleurs que voici:

blanc	éosine	cerise	sang	teint
1	2	3	4	5
chamois	lait	ivoire		corai
6	7	8		9

Les généticistes proposèrent les explications suivantes: a/ Certains firent de cette kyrielle de formes à déclancheur unique, un seul caractère à multidoses: mais il n'y a pas que des couleurs à se conduire ainsi. b/ Emerson n'y a vu qu'un cas de "liaison" très étroite: tous ces caractères seraient localisés sur des grains voisins; nos méthodes ne sont pas assez précises pour en apprécier le voisinage. c/ Morgan au contraire, croyant à la suffisante sensibilité de ses calculs, affirme que tous ces caractères sont en des points identiques dans un même grain de chromatine. d/ Dans certains chromosomes où le cordon de linine est très volumineux, nous avons vu qu'une autre explication est possible: plusieurs grains de chromatine peuvent être sur une même section du chromosome.

La manifestation de ces caractères à liaison plus qu'étroite, est de nature à embrouiller les rapports des biométriciens; une lignée bien pure de ces caractères peut manquer d'uniformité et mimer l'instabilité des hybrides. Aucun caractère héréditaire d'importance économique n'a été découvert jusqu'ici, du moins à ma connaissance, appartenant à ce genre d'hérédité.

Un dernier type est celui des "Facteurs multiples".

C'est l'antitype du précédent, c'est son contraire. Dans le 6ème type, nous avions plusieurs caractères, localisés sur un même point de la chromatine; dans le 7ème type, le concours de différents grains appartenant à divers chromosomes, est nécessaire à la production d'un effet unique. Exemple: l'oeil rose de Drosophile est à un point du chromosome X et à un autre du 3ème chromosome. Ces caractères apparaissent très rarement; il est aussi extrêmement rare d'en obtenir une culture sans mélange. D. Kislovsky a localisé sur différents chromosomes le caractère "ailes tronquées"; il essaya durant 100 générations de le fixer; à la F^{100}, 10% des individus ne le possédaient pas encore. Imagine-t-on 100 générations de chevaux ou de bovidés!

12—Essence et stabilité des caractères héréditaires

Une chose doit nous frapper dans l'étude que nous faisons présentement des types héréditaires: c'est l'entière stabilité accordée au siège de l'hérédité. On s'y attache avec force, car elle est essentielle. Seule, elle peut permettre le passage continu, à travers de nombreuses générations successives, de telle qualité ou de tel défaut; seule, elle peut nous en assurer l'utilisation ou le contrôle. Nous regardons la régularité des manifestations héréditaires comme un indice de celle de leur cause. La persistance de l'acte suppose la stabilité de l'être, présentement de ce lieu de la cellule, — protoplasme, chromosome, chromomère, fraction de chromomère ou bien tout cela à la fois,—où siège la force déterminante de l'hérédité. Nous sommes aussi ignorants de la réalité biologique des caractères que de l'essence de la formule moléculaire. Une école incline vers le dynamisme, la plupart des biologistes cependant sont matérialistes. Aucune distinction entre caractères physiques et caractères moraux; la vie: c'est la matière. A ce prix, "rien n'interdit de supposer que les sciences expérimentales puissent réussir à reproduire artificiellement un jour les machines vivantes." (Jacques Loeb: "La dynamique des phénomènes de la vie".)—Pourtant Giard qui signa la préface de l'ouvrage précité, sentit le besoin de faire une réserve: "Vouloir appliquer strictement à la matière vivante, les principes ordinaires de la mécanique actuelle, n'est-ce pas exagérer la valeur explicative de ce qui n'est au fond qu'une première approximation de la vérité?" Claude Bernard, de son côté, affirma: "Il est clair que cette propriété évolutive de l'oeuf qui produira un oiseau, un poisson ou un serpent, n'est ni de le physique, ni de la chimie."

N'admettre aucune distinction entre ces facteurs de qui relèvent les caractères moraux et ceux commandant aux autres réactions somatiques, est une grave erreur, puisque c'est confondre en nous, la vie végétative, la vie animale et la vie humaine. "Je ne puis comprendre, dit Armand Gautier, que ce même instinct chimique qui nous porterait, suivant Loeb, nécessairement, en vertu d'une réaction matérielle obligatoire, au sentiment de notre conservation personnelle, soit justement celui qui pousse le vaillant à courir bravement au feu pour défendre son pays, ou celui qui envoie nos missionnaires mourir en pays sauvage ... les phénomènes des conscience, de pensée, de volonté, qui constituent la vie supérieure, sont des états et non des actes matériels." (Revue Scientifique, 27 avril 1912).

Les affirmations matérialistes apportées à l'explication de la nature des facteurs sont impuissantes à abimer la théorie animiste. Sait-on, en effet, quelle est l'essence de la matière, de cette matière que nos philosophes appellent "première", et à laquelle la science moderne semble vouloir retourner? Quelle est la nature de l'électron? Au reste, les biologistes les plus hardis sont d'accord pour avouer leur ignorance presque complète sur ce sujet. La chimie moderne est ouvertement hostile à la théorie chromosomienne entendue au sens matérialiste (Cf. General Cytology, 1924, cf. art. P. Mathews.)

13—Le recoupement (Crossing over)

Drosophile dont nous avons plus haut résumé les services, en rendit un dernier qui

ébranlá un instant toute la théorie chromosomienne et jeta un gros point d'interrogation, à la face de l'hérédité corrélative de ces caractères que de multiples expériences avaient démontré infrangiblement unis. Hébergés dans un même substratum héréditaire, les caractères liés doivent forcément passer d'une génération à l'autre, à la façon d'un tout, d'une unité; autrement dit, les caractères doivent subir la même destinée que le ruban de chromatine qui les porte. Ainsi, les caractères suivants: corps gris — ailes longues, sont situés sur un même chromosome. Jamais on ne les avait rencontrés séparés. Or, un jour, quelle ne fut pas la surprise de voir sortir, d'une nouvelle génération, 8.5% des individus avec corps gris et ailes courtes; un autre groupe de 8.5% avec corps noir et ailes longues!

D'après Morgan et son école, on s'en souvient, le chromosome porte un certain nombre de caractères, disposés en file, à des places bien déterminées. On s'arma donc aussitôt du microscope pour voir ce qui se passait d'anormal dans le noyau. De nombreuses préparations microscopiques de mitoses et de meioses montrèrent de fréquents cas où deux chromosomes voisins enjambaient l'un sur l'autre, s'enroulaient ensemble, surtout à la métaphase,—stage de la plaque équatoriale. C'est ce que les génétistes anglais appelèrent: "Crossing over". Le plus souvent ces chromosomes qui se recoupent, ne font qu'un tour l'un autour de l'autre; parfois cependant nous assistons à des enroulements à multiples tours. A un moment donné de la division mitotique, les deux centrosphères entrent en action et attirent à elles, chacune, la moitié du nombre des chromosomes. Ces derniers, tels que révélés par les récent travaux des cytologistes, de Chambers en particulier, sont de substance visqueuse, collante; un rien les brise. L'attraction des deux pôles est plutôt violente; les chromosomes enroulés, ne pouvant se "décroiser" assez tôt, se brisent par leurs points de contact, échangeant entre eux des tronçons de chromosomes et modifiant ainsi leur teneur en caractères héréditaires. Les chromosomes, à présent formés de deux tronçons, montent se tasser autour des pôles ou plusieurs avec leurs nouveaux patrimoines.

Que la génération suivante ait un stock héréditaire aberrant, rien que de très naturel. Les cross-over, une fois leur mécanisme connu, loin de saper la théorie chromosomienne, n'en sont qu'une magistrale confirmation. Il faudrait un petit cours pour traiter à fond cette cause intéressante de changements dans l'hérédité qui ne sont pas de l'instabilité, mais plutôt des remaniements de corrélations héréditaires. Cette théorie, de jour en jour, gagne en certitude.

14—Les mutations

L'expérience séculaire des éléveurs et des horticulteurs affirme l'existence d'une autre sorte d'instabilité des notes héréditaires; l'héréditaires *per saltum* est connue depuis longtemps; on lui a donné une foule de noms; sport, hybride de greffe, variation discontinue, variation brusque... mais tous ces noms ont été absorbés par l'expression "MUTATION", très à la mode depuis qu'a paru le "Die Mutation théorie" (1900-1903) de Hugo de Vries. Mutation veut dire saut instantané d'un individu, végétal ou animal, hors de son cadre spécifique;—transformation actuelle des espèces s'effectuant par saut brusque, (Cours de Fr. M. Victorin);—altération brusque et discontinue du biotype (Johannsen). Je ne fais que mentionner cette théorie très importante sur laquelle j'aurai occasion de revenir.

La mutation et le crossing-over constituent deux nouveaux types héréditaires; ils sont accidentels. Le premier rare, capricieux, incontrolable; le second plus fréquent, réglé, apparait dans des proportions bien définies 1/100; 10/100, 18/100,... il peut atteindre 80/100.; il est controlable. Tous deux sont dus à un changement de chromatine nucléaire.

Au point de vue amélioration des races, ils sont d'une haute valeur; les mutations ne se reconnaissent qu'après coup, pourvu qu'on se donne la peine de les observer; elles sont fixes et demeurent pures si on les isole; le cross-over rend possibles ces associations entre caractères semblant réfractaires à toute union. Et probablement nous devrons la création d'une nouvelle variété de blé résistante à la maladie et de bonne qualité boulangère à un recoupement (cross-over) de ce genre.

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ACTIVITES DES SECTIONS

Section de Montréal

Le dernier diner-causerie de cette section à eu lieu, au Cercle Universitaire, le samedi 27 mars. Le conférencier fut monsieur Stanislas Chagnon, du service de l'Industrie Animale, à la ferme expérimentale Centrale d'Ottawa, qui prit comme sujet: "Le revenu du cultivateur et les moyens de l'augmenter." M. Henri Bois, professeur d'économie rurale à l'Institut agricole d'Oka, se chargea de remercier le conférencier au nom des 32 convives, parmi lesquels nous avions le plaisir d'avoir comme hôtes, le Dr. Lafortune, de Hull, président de la Société Chanteclerc, et M. W. W. Lee, du Service de l'Aviculture à la Ferme expérimentale d'Ottawa.

Sur motion de M. Arthur Lamarre, Agronome officiel à Laprairie, il a été adopté à l'unanimité des membres présents, qu'une expression de cordiales sympathies soit transmise au camarade Anthime Charbonneau, Agronome officiel à Joliette, à l'occasion de l'épreuve cruelle subie par la perte de son père et de sa mère, dans l'espace de 15 jours.

Section de Québec

La réunion annuelle à eu lieu le lundi 12 avril, dans le bureau du Service de l'Entomologie, au parlement de Québec. Les élections pour le renouvellement de l'exécutif de l'année qui prend cours au mois de juin prochain, ont donné les résultats suivants:

Président—Monsieur J. Chs. Magnan, Agronome officiel du Comté de Portneuf;

Vice-Président— Monsieur Antonio Mathieu, surintendant des champs de démonstration du département d'agriculture à Québec;

Sécrétaire Trésorier—Monsieur Omer Caron, Botaniste officiel au département de l'agriculture.

Section de Ste. Anne de la Pocatière

Ce groupement a profité de l'exposition provinciale de semences, organisée à l'école d'agriculture, pour tenir sa réunion annuelle le 23 mars à 7 heures et demi du soir, dans les locaux de l'école même. Une conférence fut donnée par le Dr. G. P. McRostie, agrostologiste du Dominion.

Si nous tenons à féliciter bien sincèrement la jeune section de Ste Anne de la Pocatière, pour l'activité remarquable déployée depuis sa fondation, il nous sera cependant permis d'exprimer le regret d'avoir trop rarement reçu des comptes-rendus de ses diners-causerie et conférences, jusqu'ici.

BOOK REVIEWS

THE NATURALISTS' GUIDE TO THE AMERICAS (The Williams & Wilkins Company, Baltimore, Md., 761 pages, with 15 maps. $10.00).

This naturalists' guide has been prepared by a committee appointed by the Ecological Society of America, and edited by the Chairman of the committee, Doctor V. E. Shelford. A large number of workers assisted in contributing data and several institutions and organizations aided in various ways. It presents an immense amount of valuable data on the original biota and the natural habitats of the American continent.

A chapter on "Uses, Values and Management of Natural Areas" contains nineteen articles dealing with the conditions on natural areas, their relation to our civilization and the need for their preservation.

The third chapter discusses the original biota of the Americas north of the Amazon, giving a table of life zones with vegetation types, and listing the principal trees, mammals and birds of the various biotic areas.

The main body of the book, 638 closely printed pages, deals with the natural areas and regions of the continent. The territory is divided into three sections: Northern Tundra, Temperate America and Tropical America. For Southern Canada and the United States a general account of biotic conditions is given, and specific descriptions of natural areas. An account is given of the primitive condition of the territory before being modified by civilization; general physiographic features are described and geographic and local plant and animal communities are briefly outlined.

As the preface states, the book will be useful principally to students of mammals, birds and general ecology. Little information is given respecting the lower vertebrate and invertebrate life. Entomologists, for example, will be disappointed that data on insect life has not been included. The book contains a vast amount of information and will prove invaluable to all students of ecology.—J.M.S.

ROOT DEVELOPMENT OF FIELD CROPS, by John E. Weaver (McGraw-Hill Book Company, 291 pages, Illustrated. $3.00).

This book is of particular importance and interest because it gives, in considerable detail, information on a subject upon whi[ch] there is comparatively little literature avai[l]able. The first three chapters describe th[e] composition and texture of soils, the stru[c]ture of roots and their method of growth, ro[ot] habits in relation to crop production, et[c]. Chapter four deals with the root habits of va[r]ious native plants. Chapters five to sixtee[n] cover the root habits of wheat, rye, oats, bar[]ley, maize, sorghum, meadow and pastu[re] grasses, sugar beets, alfalfa, clovers, pota[toes] and sunflowers. Each of the first sixtee[n] chapters concludes with a brief summar[y]. The last chapter is an extremely interestin[g] description of the methods adopted in mak[]ing plant selections for root study and i[n] obtaining, photographing and describing th[e] various root systems.

The author is Professor of Plant Ecology [at] the University of Nebraska.—F.H.G.

ALFALFA GROWING IN THE UNITED STATES AN[D] CANADA, by George Stewart, (Macmilla[n] Company of Canada. 517 pages, Illustra[t]ed, $3.50)

This book by the Professor of Agronomy [at] the Utah Agricultural College is particularl[y] timely. The production of alfalfa in Canad[a] while it shows considerable increase durin[g] the past decade, is almost certain to develo[p] tremendously in the immediate future. On[]tario and Quebec in the east, and Alberta i[n] the west are already making rapid increase[s] in acreage, and in every province from whic[h] figures are available expansion is reported.

This new volume, which is an addition t[o] the Rural Science Series edited by L. H[.] Bailey, covers every phase of the crop. Th[e] earlier chapters deal with the importance o[f] alfalfa, its history, varieties, adaptation, et[c]. These are followed by a complete outline o[f] cultural methods, irrigation, cutting and cu[r]ing, marketing, etc. One chapter covers i[n]sects and diseases, and the two closing cha[p]ters deal with chemical composition and fee[d]ing value. There is an extensive bibliogr[a]phy and index.

"Alfalfa Growing" will undoubtedly b[e] useful, if not indispensible, to progressi[ve] Canadian farmers, to agricultural students, t[o] extension workers and to teachers. Practica[l]ly all of the information given in the book [is] based on experimental results.—F.H.G.

PRINCIPLES AND PRACTICES OF CO-OPERATIVE MARKETING, by E. G. Mears and M. O. Tobriner. (Ginn and Gompany, 580 pages, Illustrated. $3.00).

One would have thought that the subject of co-operative marketing had been exhausted n the many publications which have appeard in the past ten or fifteen years, and that nyone interested in any phase of the probem could find adequate material. Yet this ew book appears to have avoided duplicaion, due to the manner in which the subject s treated and the rural background upon vhich the text is laid. "Social aspects, hisorical narrative, and the international phases . . . have been stressed throughout the book". t has been written too, at a time when the results of co-operative organization and management are fully known and when definite and significant conclusions have been reached.

The subject matter is divided into five parts: (1) General Introduction, (2) Organization, (3) Business Practices, (4) Regional Characteristics and (5) Conclusion. These include twenty-two chapters. There are five appendixes, dealing with questionnaires sent to numerous American and Canadian co-operative marketing associations, statistics, by-laws and forms of contract, etc.

The senior author is Professor in the Graduate School of Business and Lecturer in Cooperative Marketing at Leland Stanford, Jr. University.—F.H.G.

Concerning the C.S.T.A.

THE JUNE CONVENTION

From every standpoint, the coming Convenion at Ottawa will be the finest in the hisory of the Society, and members should be naking their plans now, so that they will e sure to attend. The dates are June 23rd o 26th. and the headquarters for the Convenion will be at the Chateau Laurier.

Among those who have already agreed to ttend and give advanced lectures are Dr. . B. Morrison, Professor of Animal Husbanry at the University of Wisconsin, Dr. Wm. rocker, Director of the Boyce-Thompson Initute for Plant Research at Yonkers, N.Y.. nd Dr. D. F. Jones, Plant Breeder at the gricultural Experiment Station, New Hav-, Conn. Three other lecturers are yet to be hosen by the Programme Committee.

A feature of the Convention will be the resence of Senator Arthur Capper of Kansas, ho is making his first visit to Ottawa at the vitation of the C.S.T.A. He will address e members at a Banquet on June 25th, at hich the Prime Minister of Canada has greed to preside.

The Convention is being held under the stinguished patronage of their Excellencies the Governor General and Lady Byng of Vimy. Official programmes will be mailed to all C. S. T. A. members about May 25th. Everything possible is being done to ensure accommodation at reasonable rates and to keep the incidental expenses of members at as low a figure as possible.

BUREAU OF RECORDS & EMPLOYMENT

Cards for the Records Section of this Bureau are not being returned as promptly as might be wished. Only about 20 per cent of these cards have yet reached the General Secretary and further development of the Bureau is being delayed. It is hoped that members will show greater desire to cooperate in this organization work so that a complete report may be presented at the time of the Annual Convention.

NOTES

Dr. Wm. Allen, Assistant Professor of Farm Management at the University of Saskatchewan has recently published a bulletin entitled "How to Take a Farm Inventory and Make a Credit Statement."

L. E. Kirk, Professor of Field Husbandry at the University of Saskatchewan has obtained leave of absence to continue his graduate studies at the University of Minnesota next winter.

W. W. Lee, Poultry Husbandman at the Central Experimental Farm, Ottawa, has resigned his position to take graduate work at the University of Wisconsin. He has been with the Poultry Division since June, 1921.

Dr. R. Newton gave a series of lectures at the University of California, during the week of April 5th, on the research work in progress in the Dept. of Field Husbandry at the University of Alberta. On his return journey to Edmonton he visited the experiment stations at Riverside, Cal., Logan, Utah, and Bozeman, Mont.

The Corn Belt Section of the American Society of Agronomy will meet at University Farm, St. Paul, Minnesota, on July 15, 16 and 17. A program of inspection and discussion will be followed with some side trips to points of interest. Two or three societies with allied interests are planning to meet at University Farm at the same time.

The Civil Service Commission at Ottawa is advertising for three Assistant Plant Pathologists, one each for Summerland, B.C., St. Catharines, Ont., and Kentville, N.S. The initial salary is $1,920 per annum, with increases of $120 per annum up to a maximum of 2,280. Applications must be in the hands of the Civil Service Commission not later than May 13th.

At the recent annual meeting of the Alberta Branch, C.S.T.A., the Secretary, Prof. J. Macgregor Smith, reported an increase in membership during the year from 45 in April, 1925 to 98 in April, 1926. This is a record of which any local might well be proud. Five meetings were held during the year.

The next meeting of the Niagara Peninsula local will be held at the Village Inn, Grimsby, on Saturday, May 8th, at 12.30 p.m. Any C.S.T.A. member will be welcome.

The annual meeting of the Western Ontario local will be held at the Engineers' Club, Toronto, on Friday, May 7th. A large attendance is particularly requested.

APPLICATIONS FOR MEMBERSHIP

Since the publication of the List of Members in February last, the following applications for membership have been received:—

Baxendale, R. D. (British Columbia, 1925, B.S.A.) Lloydminster, Sask.

Howe, J. W. (Alberta, 1925, B.S.A.) Edmonton, Alta.

Johnston, J. T. (Toronto, 1916, B.S.A.) Dutton, Ont.

Ross, H. R. (Toronto, 1898, B.S.A.) St. John, N.B.

Roy, Alphonse (Laval, 1913, B.S.A.) Montreal, P.Q.

Smith, Wesley (Alberta, 1925, B.S.A.) Millet, Alta.

G. C. Creelman

ELECTION RESULTS

Just as we go to press, the results of the Dominion election of C.S.T.A. officers for the year 1926-27 have come to hand. They are as follows:—

President—G. C. Creelman, Beamsville, Ont.

Vice-Presidents—H. S. Arkell, Ottawa, Ont., and L. P. Roy, Quebec, P.Q.

Hon. Secretary—L. H. Newman, Ottawa, Ont.

There were 616 ballots received. The newly elected officers will assume their respective duties on June 1st, 1926.

A Statistical Study of the Characters of Wheat Varieties Influencing Yield.*

C. H. GOULDEN
Cereal Specialist, Dominion Rust Research Laboratory and
A. T. ELDERS
Instructor in Botany, Manitoba Agricultural College, Winnipeg

For the efficient and rapid solution of ıy plant breeding problem by the combina- ɔn of desirable varietal characters, a know- dge of the inheritance and relative value of ese characters is of primary importance. heritance studies very largely indicate the ode of attack on the problem but the mode attack is not completely known until the sirability of the various characters worked ith has been either quantitatively measured closely estimated, as in each operation it is ıly upon a few characters that the plant eeder's attention can be concentrated.

In wheat improvement the primary objec- ves are *yield* and *quality*. Yield is a com- icated character, determined undoubtedly a series of lesser physiological and mor- ɪological characters such as disease resis- nce, earliness, height, number of stools per ant and strength of straw. As to the rela- ve importance of these, we have relied iefly upon general observations which have abled us to draw some conclusions of con- derable value. Thus it is a common ob- rvation that rust resistant varieties give e highest yields when stem rust is preval- t and that early varieties are superior when rly fall frosts occur or hot drying winds the latter part of the season. Again, early rieties also lessen the damage from rust the wheat matures before the rust can do maximum amount of injury. Such ob- rvations and conclusions are recognitions non-mathematical language of a correlation tween yield and the characters mentioned d the subject immediately presents itself one capable of statistical analysis. In nnection with the rust problem an attempt being made at the Rust Research Labora- y to carry out such a program, and it is e purpose of this paper to present the re- lts of a study of the correlations between eld and four important characters of wheat varieties: susceptibility to stem rust, susceptibility to leaf rust, earliness, and strength of straw, for 146 varieties of wheat grown in the experimental field of the laboratory during the season of 1925.

Materials and Methods

The varieties studied were grown in triplicate rod rows replicated three times. Yields were taken on the centre rows of each plot and the average yield determined of the four plots of each variety. Strength of straw and earliness were determined for all of the plots of each variety but rust percentages were taken on only two series. A high correlation between the rust percentage estimates of the first and second series indicated that it was unnecessary to take notes on more than two series.

When the calculation of the averages was completed and the varieties finally arranged in order of yield it was evident that there was a distinct tendency for the yields to decrease as the percentage of stem rust increased. With respect to the other characters, association with yield was not evident from a mere inspection of the tabulated data, so it seemed desirable that this be actually determined by calculation of the correlation coefficients.

The following notes are explanatory regarding the five characters worked with and the symbols to which they correspond in the mathematical notation:—

1. YIELD (Y) Tabulated as bushels per acre.
2. SUSCEPTIBILITY TO STEM RUST (R) It was assumed in measuring this char-

* The rust notes were taken by Dr. D. L. Bailey and Mr. F. J. Greaney of the Pathology staff of the Rust Laboratory. The analysis of the data was undertaken as a cooperative project between the Rust Laboratory and the Botany Department of the College.

acter that it might be considered as a direct function of the degree of infection. However, it was obvious that resistance or susceptibility could not be indicated directly by the estimated percentage of the surface of the plant covered with pustules, as the size and nature of the pustules are also valuable indications of the degree of resistance. While taking the rust percentages the coöperating pathologists noted the type of pustule as 1, 2, 3, or 4, the last number indicating the greatest degree of susceptibility. Thus a plant having 60 percent of its surface covered with pustules of type 1, is much more resistant than another with the same amount of its surface covered but with pustules of type 3 or 4. An arbitrary figure which seemed to most reasonably indicate the susceptibility of the varieties was obtained by multiplying each percentage by ¼, ½, ¾, 1, according as the pustule type was 1, 2, 3, or 4.

3. Susceptibility to Leaf Rust (L). This character was assumed directly as equivalent to the percentage of the surface covered with pustules. As yet we know very little regarding the diffe types of infection of this rust an was thought best not to attempt to m fy the percentage readings accord to the pustule type.

4. Earliness (H) Measured as the n ber of days from seeding to head This appeared to be a more consist measure of earliness than the num of days from seeding to ripening.

5. Strength of Straw (S) Estimated a percentage scale.

Under the conditions which existed dur the growing season of 1925 it was possi to make observations on all of the ab characters with a considerable degree of curacy. A heavy epidemic of both leaf stem rust occurred. The leaf rust as us appeared first and was well developed bef there was sufficient stem rust to make it ficult to estimate percentages of the form The growth of straw was a little above av age and fairly severe wind storms enab us to estimate the strength of straw in a v satisfactory manner.

From the very nature of the data it evident to the writers that only a rough m

Table I. Correlation Surface for Yield and Susceptibility to Stem Rust.

Yield in Bushels Per Acre (Y)

Susceptibility to Stem Rust (R)	8.2	11.7	15.2	18.7	22.2	25.7	29.2	32.7	36.2	39.7	43.2	46.7	
4.5						1	2	1	1	1	2	1	9
14.5							2						2
24.5							1	1	1				3
34.5			1			1	1			1			4
44.5			1	2	2	8	2		2				17
54.5				1	2	6	2	1					12
64.5				2		1	2						5
74.5		1	3	6	2	5	3						20
84.5	1	2	11	8	9	6	1						38
94.5	2	9	5	5	8	5	2						36
	3	12	21	24	23	33	18	3	4	2	2	1	146

$r_{YR} = -.666 \pm .031$

ure of the degree of correlation could be obtained by calculating the simple product moment correlation coefficients. As is well known the validity of the correlation coefficient as a measure of association depends on (1) the linearity of regression and (2) the accuracy with which numerical values can be assigned to the variables concerned. With respect to the variables being correlated in his study, two of them, susceptibility to leaf rust and susceptibility to stem rust, could not be assigned numerical values with any great degree of certainty that they represented the actual facts, and this is at least partly indicated by the abnormal distribution in both cases. When only one of the variables is of this type a more reliable measure of correlation can be obtained by calculating the correlation ratio η (Pearson 5), but when both variables are of this type contingency methods (Pearson 4) only are strictly applicable. Of the ten correlation surfaces in his study only one of them, that for *R* and *L* was such as to be likely to demand contingency methods, (†) and an actual determination of C the coefficient of mean square contingency showed that this value was not greatly different from r or η. For the remainder of the tables it was evident that η would give quite an accurate measure of the correlation and that r would be fairly accurate where regression was linear. For each correlation surface therefore the two possible values of η were calculated as well as r and the linearity of regression tested by means of Blakeman's Criterion (2) in which the magnitude of $\xi = \eta^2 - r^2$ is compared with its probable error obtained according to the formula—

$$\tfrac{1}{2}\sqrt{\xi} \times \chi_1 \sqrt{1+(1-\eta^2)^2-(1-r^2)^2}$$

The values of ξ do indeed indicate that r can only be used as a rough measure of association in many of the cases considered. However since the value of r is necessarily always less than η for the same distribution it follows that significant values of r cannot lead one to draw erroneous conclusions as to the existence of association. For values of r approaching zero, however, we cannot state with any degree of assurance that there is no correlation. And, on the other hand, to use the values of η when r is zero also might not be justifiable as the number of classes was large in comparison with the number of pairs of

† In calculating contingency from an ordinary correlation surface as in this case it is of course desirable to group the arrays of both variables so as to reduce the number of cells.

Table II. Correlation Surface for Yield and Susceptibility to Leaf Rust.

Yield in Bushels per Acre (Y)

Susceptibility to Leaf Rust (L)	8.2	11.7	15.2	18.7	22.2	25.7	29.2	32.7	36.2	39.7	43.2	46.7	
4.5	1		1	2	2	7	5	2	2	1	2	1	26
14.5		3	5	5	1	5	3		1	1			24
24.5		2		1	3	3	1						10
34.5		2	2	2	1	4	2	1	1				15
44.5	2	1		1	5	2	3						14
54.5			1	4	2	1							8
64.5			2	1	2	1	2						8
74.5			7	2	2	3	1						15
84.5		4	1	6	1	5	1						18
94.5			2		4	2							8
	3	12	21	24	23	33	18	3	4	2	2	1	146

$r_{YL} = -.297 \pm .051$

measurements and under these conditions it is common knowledge that the calculated values of η may be too great.

The partial correlations coefficients of the third order were calculated by the normal equation method from the simple product moment coefficients (‡).

Results and Discussion

The correlation surfaces given in Tables I, II, III, and IV, and the regressions illustrated in Figures I, II, III, IV, V, and VI show the general relationship between yield and the other four characters. On the regression graphs it will be noted that the frequencies of the variates entering into the determina-

‡ In literature citations it is scarcely possible to include all of the references on actual methods of calculation. Some of the most important of these are:
Harris, J. Arthur, The Arithmetic of the Product Moment Method of Calculating the Coefficient of Correlation, Amer. Nat., 44: 693-699, 1910.
————., Correlation and Machine Calculation, Amer. Nat. 59: 363-366, 1925.
Wallace, H. H., and George W. Snedecor., Correlation and Machine Calculation, Iowa State College of Agri. and Mech. Arts. Off. Publ., Vol. 23, No. 35, 1925.

tion of the empirical means have been g
in a horizontal row across the top of
graph. This enables one by inspectio
discount the wide variations of certain m
of arrays from the regression line, due to
small number of individuals which enter
their determination. In the interpretatio
these results it must be kept in mind that
data were obtained from a rather heterô
eous group of wheat varieties which one w
not be justified in assuming to be a ran
sample. In fact the sample could not
truly random one owing to the selection
inclusion in the test of certain groups
wheat varieties on account of particular c
acters which they possessed. It is owin
the selection of such groups of varieties h
ever that a statistical study of the relat
between certain characters was possible.
the case of rust resistance and yield, if a g
of varieties showing resistance had not
included, the gradations of this chara
would not have been present and consequ
ly its relationship with yield would not
been demonstrable by statistical methods

In the season of 1925 a considerable am
of damage was done by stem rust. On
same plot of land on which the variety

Table III. Correlation Surface for Yield and Days from Seeding to Heading.

Yield in Bushels per Acre (Y)

Days from Seeding to Heading (H)	8.2	11.7	15.2	18.7	22.2	25.7	29.2	32.7	36.2	39.7	43.2	46.7	
55.1					1		1						2
57.0								1					1
58.9				2	5	6	4		2				19
60.8		1	1	4	6	10	3	1					26
62.7		1	4	4	6	5	4		1	1			26
64.6		1	2	9	4	7	3	1	1		2	1	31
66.5	1		9	4		5	3			1			23
68.4	1	6	4	1	1								13
70.3		1	1										2
72.2		2											2
74.1	1												1
	3	12	21	24	23	33	18	3	4	2	2	1	146

$r_{YH} = -.431 \pm .045$

scussed here was conducted, and in the same ason, it was shown (Bailey and Greaney, 1) experiments with Marquis wheat in which th leaf and stem rust were controlled by plications of sulphur dust that in some ses rust was responsible for a 76 percent duction in yield. It was not difficult there-re to demonstrate its effect on yield by cor-lation methods. As shown in Table I and gure I the relation between yield and sus-ptibility to stem rust was very distinct and course negative.

In connection with Table I it is of interest note the abnormal frequency distribution the stem rust classes. As pointed out ove this may be due to the impossibility of igning exact numerical values to the dif-rent categories, but it is also an indication selection for rust resistance in the varieties llected. Assuming that the distribution of true random sample of the varieties is nor-al, selection of highly resistant ones would crease the length of the tail of the distri-tion towards the resistant end.

The existence of a negative correlation be-een yield and susceptibility to leaf rust also indicated by the results but such a relationship is necessarily difficult to demon-strate in the presence of stem rust. The simple coefficient r_{YL} has the value —.297 and the coefficient of third order $r_{YL \cdot RHS}$ has the value of —.456. Considering first the simple coefficient it is evident that this may be due to r_{YR} and r_{RL} since the former is negative and the latter positive. Calculating $r_{YL \cdot R}$ we have a coefficient of $-.191 \pm .054$ which is just barely significant. The coefficient of third order however is —.456 and is evidently high-er than r_{YL} due to $r_{YH} = -.433$ and $r_{LH} = -.280$. The true value of the correlation r_{YL} is therefore bound up in the validity of the two coefficients r_{RL} and r_{HL}.

Examination of Figure VI and the value of ξ given in Table V shows that the regres-sion of L on R is distinctly non linear if such a relation exists at all. However the group of varieties showing resistance to both stem and leaf rust are practically all durums and if the two groups were separated the correla-tion in both groups would probably be very small. The value of r_{RL} may therefore be re-garded as largely spurious due to the hetero-geneity of the material. In the case of r_{LH} its value of —.280 is considered to be chiefly

Table IV. Correlation Surface for Yield and Strength of Straw.

Yield in Bushels per Acre (Y)

Strength of Straw on Percentage Scale (S)	8.2	11.7	15.2	18.7	22.2	25.7	29.2	32.7	36.2	39.7	43.2	46.7	
20								1		1			2
27				1	3	3	3		1		1	1	13
34		1	1	1	2	2	3			1	1		12
41		1		1	4	7	3						16
48	1	1	1	4	1	7	2	1					18
55		2	4	4	2	5			1				18
62			2	4	5	5	4		1				21
69		2	5	5	1	2	1						16
76	1	1	3	1	3	1	1						11
83	1	3	4	1	2		1	1	1				14
90			1	2		1							4
97		1											1
	3	12	21	24	23	33	18	3	4	2	2	1	146

$$r_{YS} = -.433 \pm .045$$

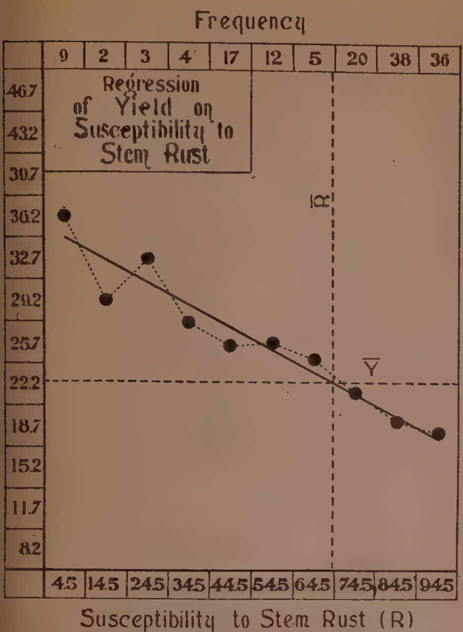
an accidental one also due to the heterogeneity of the material, since a certain group of the early varieties were all markedly susceptible to leaf rust. There does not seem to be any logical reason for greater susceptibility in early varieties so this coefficient is also probably without meaning. This brings us back to the value of the simple product moment coefficient as being the nearest possible estimate of the correlation between *Y* and *L*. It is a significant correlation, and considering the severity of the leaf rust epidemic it is not surprising that it appears to have had some effect on yield.

The relation between yield and the number of days from seeding to heading is one which is to be expected in a season in which rust is very injurious, especially in such a season as that of 1925 when the rust was relatively late in getting started and then developed very rapidly. It is well known that early varieties are rust escaping and this is borne out by the results of these studies. It is interesting to note that the partial correlation $r_{YH \cdot RLS}$ is higher than the simple coefficient r_{YH} and in this connection one should not confuse the mathematical process of holding *R* constant with eliminating the influence of rust entirely. If the latter were possible early varieties would probably not yield as much as the later ones but when we calculate $r_{YH \cdot R}$ and $r_{YH \cdot L}$ we get $r_{YH \cdot R} = -.595$ and $r_{YH \cdot L} = -.561$ as compared with the coefficient of zero order $r_{YH} = -.431$. Consequently the influence of rust on yield is emphasized more strongly by the coefficients of higher order than by the simple ones. This result and the correlations between yield and susceptibility to rust are strongly indicative of the kind of wheat variety toward the production of which plant breeding efforts should be concentrated in order that high yields may be produced in seasons such as that of 1925. Probably a totally resistant variety would not need to be a particularly early one but to obtain such a variety in a reasonable amount of time may not be at all possible. However, if a reasonable degree of resistance can be combined with earliness, injury from rust will be very greatly reduced.

As will be noted from the value of ξ given in Table V there is evidence in the case of the relation between *Y* and *H* of a nonlinear

Table V: Correlation Coefficients, Correlation Ratios, and Values of Blakeman's Criterion of Linearity for Each of the Ten Pairs of Variables.

Variables	r	r/E		η	η/E	ξ/E		η	η/E	ξ/E
YR	$-.666 \pm .031$	21.5	η_{YR}	$.679 \pm .030$	22.6	1.20	η_{RY}	$.712 \pm .028$	25.4	2.31
YL	$-.297 \pm .051$	5.8	η_{YL}	$.414 \pm .046$	9.0	2.80	η_{LY}	$.386 \pm .048$	8.0	2.35
YH	$-.431 \pm .045$	9.6	η_{YH}	$.533 \pm .040$	13.3	3.07	η_{HY}	$.620 \pm .034$	18.2	4.72
YS	$-.433 \pm .045$	9.6	η_{YS}	$.503 \pm .042$	12.0	2.40	η_{SY}	$.477 \pm .043$	11.2	1.85
RL	$.238 \pm .053$	4.5	η_{LR}	$.447 \pm .045$	9.9	3.90	η_{RL}	$.457 \pm .044$	10.4	4.07
RH	$-.019 \pm .056$	.3	η_{RH}	$.412 \pm .046$	8.9	4.44	η_{HR}	$.219 \pm .053$	4.1	2.05
RS	$.281 \pm .051$	5.5	η_{SR}	$.357 \pm .049$	7.3	2.06	η_{RS}	$.390 \pm .047$	8.3	2.60
LH	$-.280 \pm .051$	5.5	η_{LH}	$.391 \pm .047$	8.3	2.63	η_{HL}	$.347 \pm .049$	7.1	1.92
LS	$.133 \pm .055$	2.4	η_{SL}	$.243 \pm .053$	4.6	1.90	η_{LS}	$.268 \pm .052$	5.2	2.20
HS	$.125 \pm .056$	2.2	[illegible]	$.340 \pm .049$	6.9	3.15	[illegible]	$.352 \pm .049$	7.2	3.20



igure 1. Regression of Yield on Susceptibility Stem Rust. Empirical means and regression ight line.

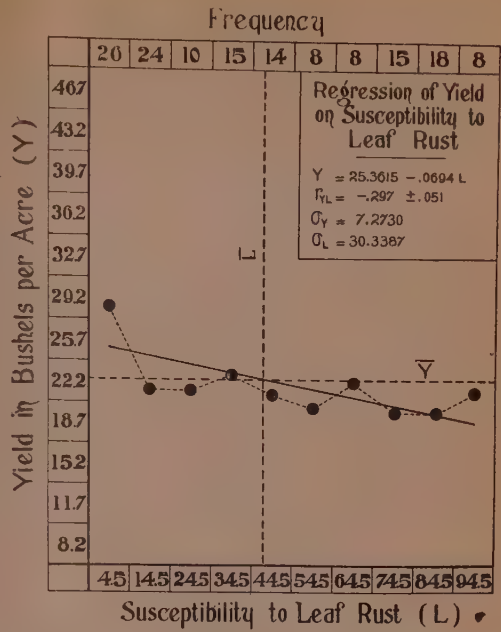
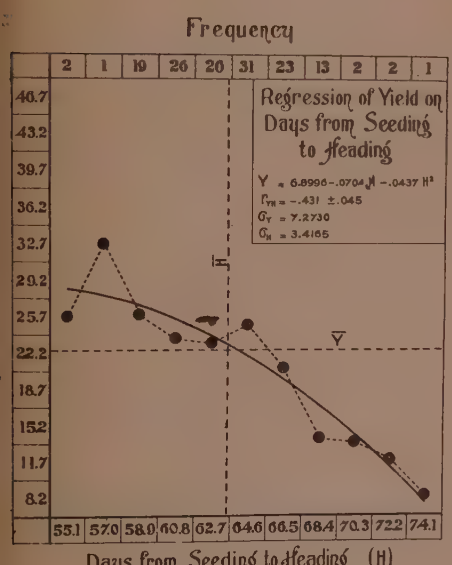


Figure II. Regression of Yield on Susceptibility to Leaf Rust. Empirical means and regression straight line.



igure III. Regression of Yield on Days from ding to Heading. Empirical means and ved regression line.

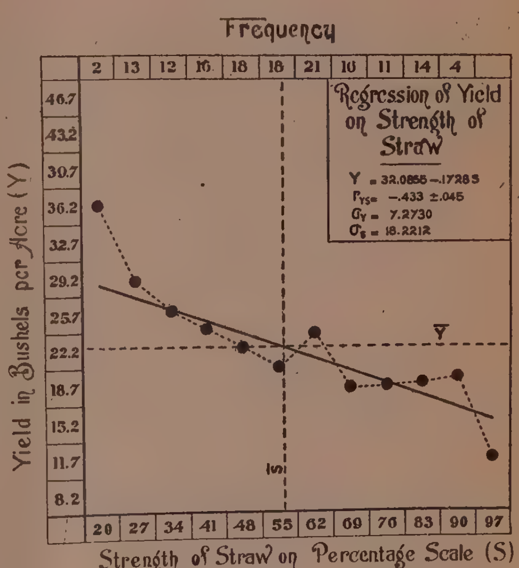


Figure IV. Regression of Yield on Strength of Straw. Empirical means and regression straight line.

regression of Y on H, and in Figure III a curved line representing an equation of the second order has been fitted to the empirical means by the method of least squares. This may also be explained on the basis of rust injury, the relative amount of injury becoming increasingly greater as the time from seeding to heading increases.

There is evidently a very interesting relation between strength of straw and the other characters considered. The coefficient, $r_{YS} = -.433$ shows that the heavier yielders were on the average weaker in the straw than the lesser yielders, or at least that they were more subject to lodging. The degree of lodging may be a direct function of the amount of grain being carried by the heads in which case it would be expected that the heavier yielders would be affected most. This would account for the positive correlation $r_{RS} = .281$, since the value of r_{YR} is high. A further explanation might be sought in the connection between morphological resistance (Hursh 3) and the structure of the straw, but there is not sufficient evidence to establish this at all definitely. It will be noted furthermore that the value of the coefficient of third order $r_{RS \cdot YLH}$ is practically zero.

SUMMARY

1. Data were collected during the seaso 1925 on 146 wheat varieties grown at ' nipeg, Manitoba, for yield, percentage stem rust, percentage of leaf rust, days f seeding to heading, and strength of straw

2. The relationships between these iables considered as characters of wheat ieties were studied by statistical methods volving the calculation of the correlation efficients of zero and third order, and of correlation ratios.

3. Definite evidence was obtained of n tive correlation between yield, and suscept ity to stem rust, days from seeding to head and strength of straw.

The first of these relationships appe to be chiefly responsible for the other tw

4. A negative relationship was also i cated for yield and susceptibility to leaf 1

5. The summarized evidence of the s points to the importance of the productio plant breeding methods of partially resis early varieties.

Table VI. Correlation Coefficients of Zero and Third Order.

VARIABLES	COEFFICIENT OF ZERO ORDER	VARIABLES	COEFFICIENT OF THIRD ORDER
YR	—.666 ± .031	*YR.LHS*	—.722 ± .027
YL	—.297 ± .051	*YL.RHS*	—.456 ± .044
YH	—.431 ± .045	*YH.RLS*	—.683 ± .030
YS	—.433 ± .045	*YS.RLH*	—.316 ± .050
RL	.238 ± .053	*RL.YHS*	—.204 ± .054
RH	—.019 ± .056	*RH.YLS*	—.490 ± .042
RS	.281 ± .051	*RS.YLH*	—.061 ± .056
LH	—.280 ± .051	*LH.YRS*	—.504 ± .042
LS	.133 ± .055	*LS.HRY*	—.047 ± .055
HS	.125 ± .056	*HS.YRL*	—.103 ± .055

$$R_{Y(RLHS)} = -.864 \pm .014$$

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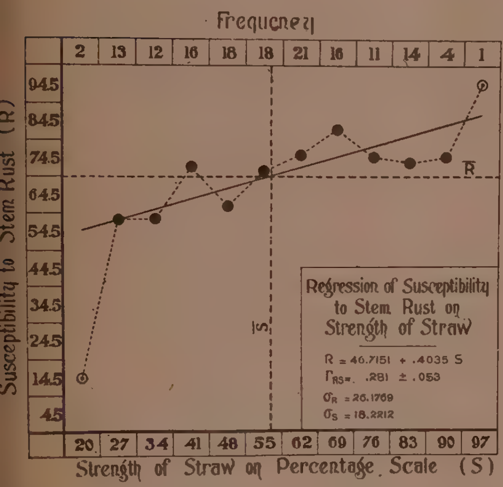

Figure V. Regression of Susceptibility to Stem Rust on Strength of Straw. Empirical means and regression straight line.

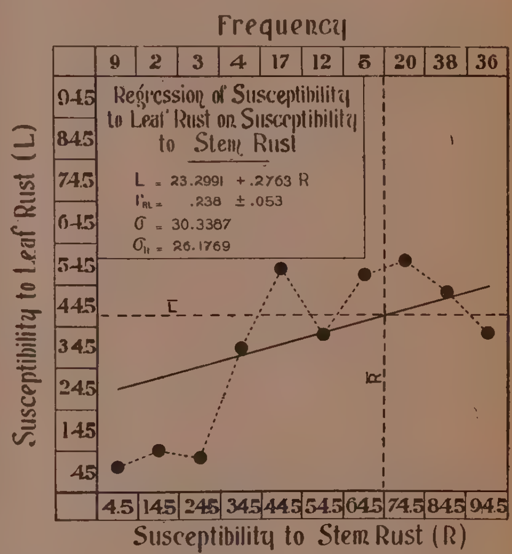

Figure VI. Regression of Susceptibility to Leaf Rust on Susceptibility to Stem Rust. Empirical means and regression straight line.

Co-ordination of Agricultural Policy in Canada.

H. S. ARKELL

Dominion Live Stock Commissioner, Ottawa.

If I am not mistaken, there is hardly a man engaged in agricultural work in Canada who is not thinking more or less earnestly, more or less seriously as to the future. In what way can propaganda work, educational work, research work be directed more successfully to our present day agricultural problems? In what way can present policies, as undertaken by different organizations, be so coordinated that the men engaged in the work of these various organizations may work together more effectively in accordance with a unit programme? When one speaks with men in different parts of the country, one finds that there is definite thinking going on, sometimes quietly, sometimes vocally, but there is, at the present moment, an accumulation of thought which more or less demands expression. Whether one finds oneself, therefore, in agreement or otherwise with prevailing public opinion, there is admittedly a distinct advantage in the discussion of these questions, in view of the interest that is being taken in them at the present time.

All this is by way of introduction. I hope you will bear with me if this proves to be a somewhat serious address, because, if I am to be of any assistance to you and if we are to make an attempt to find a logical solution to these agricultural problems, we must just quietly settle down to an informal business talk. May I ask you also to bear in mind that, in speaking of the problems which confront you in New Brunswick, we must have at the back of our minds the problems of agricultural policy of the Dominion as a whole. In dealing with the difficulties which face you in this province, we shall only be able to see them in proper prospective if, at the back of our minds, we retain a realization of the impression that is becoming more and more current, that a reorganization of our activities has now really become nothing less than a national issue. Furthermore, the impression is growing that the Province of New Brunswick is now ready to join forces with the Dominion in the working out of these problems.

I want, first of all, to give you a lit past history. The other day I was looki over an article, prepared some ten or twel years ago, for publication in one of t books that was being edited at that time. that article, emphasis was placed upon t need for perfecting our marketing machi ery. It was pointed out that, if we we to improve our production system, we cou not do so effectively, unless confidence cou be established in the marketing of the pr duct. It was suggested that a system marketing must be developed such that, wh a man produced a high grade product, would get paid for it, and that wh a man produced a low grade product, would get paid accordingly. In other word it proposed a system of sale on grade a payment according to quality.

It may be worth while stating here th during the past twelve years, Canada, as whole, has been definitely engaged in dea ing with this question, namely the perfecti of a marketing system which would encou age producers to develop and sell a hi grade product. Furthermore, the perfecti of that system has required the reorganiz tion of our whole commercial marketing pla All of you who are familiar with conditio of production at that time will realize wh we were up against. You will recall t prices that were then paid for wool—ten twelve cents per pound, I believe—as co pared with the prices, twenty-five to thir cents per pound, which the farmers are no receiving. And the point of it all is th the wool as sold at that time was not wor any more than it brought. This is som thing that we forget today. You will al recall that, at that time, eggs were sold eight cents per dozen and I am prepar to make the statement that, generally spea ing, they were not then worth any more.

As regards the prices for New Brunswi lambs in 1912-13-14, they were bringing, I am not mistaken, around $2.00 per hea Now, under the changed conditions of pr

*An address before the New Brunswi Branch, C.S.T.A., at Moncton, N.B., April 8, 19

ıction and marketing, they are commanding prices on the Montreal and Boston marets which are netting New Brunswick farıers anywhere from eight to twelve dollars er head.

The truth of the matter is that, when the roducts were being sold at the lower prices, ıere was just as much wrong with the proıction system as with marketing methods, ıt, until the marketing system was reorganed, until marketing machinery was perfectl, which would project a new principle in your whole agricultural business, you ould not undertake to go back to the farıer and tell him that he must ship only a roduct that was good, when, at that very ıoment, he would be able to get as high a rice for products that were not good. I ant you to think back to that time and to ıe conditions that then applied, as running ırough the whole gamut of agricultural proıction. I want you then to think of the rogress that has taken place during the ıtervening years. Comparative prices have lready been quoted for lambs, for eggs and ɔr wool. The same conditions apply to the roduction and marketing of hogs. Carloads f pigs are regularly leaving this province ɔr Montreal and commanding as high a rice on that market as do the hogs raised ı Ontario. I attended an organization meetıg of swine breeders this afternoon and for ıthusiasm, for intelligence, and for a genral interest in the plan of campaign, it was orth anyone's while to be present and to ealize what had been accomplished.

It may be worth while to point out that, uring the past year, a condition has arisen ı Canada that has not heretofore been dupliıted in our history. We have had a price ɔr beef cattle that is at least one cent per ound higher than a year ago. We have had price for bacon hogs of from one to three ents per pound above the level of last year's ıarket. The price for eggs has at least been ɔmparable with that of the preceding year. utter and cheese have ruled higher in price y from four to five cents per pound. While e have had throughout the country a stabiled market condition applicable to all our ırm products, this has been paralleled, withı the last two years, by perhaps the highst production that we have had in our istory. This has been accompanied by heap feed, abundant crops, and a condition of low production costs. Generally speaking, in past years when we have had cattle to sell, prices have been at rock bottom. Again, when prices of hogs have been high, we have been just out of hogs. Almost invariably the price level has been in inverse proportion to the quantity of production. Generally speaking, so far as I am aware, we have not previously in our history experienced a period of high production being paralleled by a period of high price levels, except during war years.

Is there a reason for this condition? I want to say at once that had improvements not been made in our marketing system, the conditions to which we have just referred could never have been realized. If our markets have been taking our products at good prices, it has been because the market has been willing to pay for high quality stuff and has found that we had it to sell. We are an exporting country and, in former years, Canadian products did not compare favourably with products from other countries. Today a system of marketing has been devised such that our eggs, wool, lambs, bacon, butter, cheese are going into competition with the produce from competing countries and are commanding an enviable position on the American and British markets. The marketing of quality products has established our position and has maintained a profitable outlet for the product we had to sell. I do not need further to elaborate this position but enough has been said to indicate the justification for the work that has been done during the past years, to call attention to the increasingly profitable returns to the farmers throughout the country and to the confidence that is being generally developed in rural districts as to the future of farming business.

Now, all this has been said with one particular object in view, namely to call attention to the fact that the past ten or twelve years' work in Canada has been directed toward the perfecting of our marketing machinery and to the establishment of the principle that, if a man produces a high grade article, he should be paid for it. So simple is the principle that we wonder why it was not applied before, but it required almost a revolution to make it stick.

To illustrate this, one might recall the opposition that was encountered in the initial

stages of organizing the cooperative sale of wool. The difficulties were just as great in initiating the principle of grading and of the cooperative selling of eggs and poultry. As regards the history of hog grading, you are all more or less familiar with what has taken place. It may not be out of place to say that it took six or eight years to get public opinion ready even to agree to the principle of this last undertaking and it has taken four more years to get it established in the country. Nothing now can kill it, because people have at last begun to realize that the general principle at the back of this plan is sound, that it will work, that it means money to the producer and that it provides a promising future for the industry. Today people have begun to forget individual prejudices and to think nationally as regards the development of their business. Thus we have passed through one great cycle in commercial agricultural development.

The time has now come for us, however, once more to take stock of our position. Again we have reached a period of change. Conditions that required the drafting of certain plans and policies ten or twelve years ago have advanced to a place where we shall be obliged to readjust the plans and policies of our work in relation to present developments. It may be that what I am about to say will not be accepted publicly. It may be that the public generally has not yet shifted from the opinion that our problem still is one of marketing. I believe, however, that we have reached a place where the problem of marketing is behind us and that a new problem confronts us. It is this which I wish to set before you tonight.

I have referred to an improvement in quality that has paralleled the improvement in our marketing system. Unfortunately, however, there still remains a great problem of production that has not yet been touched. I want you to think, for a moment, of the general conditions of farm management throughout the country—if you like throughout the Province of New Brunswick. I want you to think as against the improvement that has been effected in hogs, of the opportunities that still offer; as against the improvement in the quality of our wool and lambs, of the possibilities for extension in this same direction. More than all, I want you to consider that, notwithstanding all the work that has been done to date, we have not yet effectively faced the problem of increasing our returns from cattle. We have, of course, our fine pure bred dairy herds,—wonderful records for individual cows. We have our sire work and our Record of Performance work and our Cow Testing work but, notwithstanding this, the average cow of the country still produces probably not more than 4,000 lbs. of milk per year. While the average farmer is satisfied with this small return, dairying must remain an unprofitable industry.

I wish you to think of another condition, viz, that eggs and poultry, sheep and lambs, pigs even, are more or less side lines of the average farm. While the work that has been done in these directions has helped the farmer, it has not yet touched the major industry of the farm, since, generally speaking, throughout the country, farmers are obliged to make their living out of cows. When we approach the question of the breeding and feeding of cattle, we are dealing with the main issue of farm business, since around it the whole policy of farm management and of farm work turns. The farmer grows crops to feed cattle. He alternates his crops, he manages his farm to feed cattle. The feeding of pigs and of lambs and of hens is after all a secondary consideration. When we tackle the cattle problem, we get to the heart of agricultural policy and we have not yet solved it. If you will think this question through, the problem of the admittedly inferior quality of the cattle of our average farm, you will agree with me that we are concerning ourselves with the most difficult, yet the most important feature of our agricultural work. You must agree with me further that it is not a matter of marketing at all. Any man that has milk to sell can find a market for it if he produces clean milk. If he has cattle to sell, he need have little worry about the outlet or about the price if he has good cattle. It is, therefore, a question of production, primarily and fundamentally, and it can only be solved by injecting into the methods of production the principles of ordinary business.

You are probably aware of the interest that is being directed to the improvement of beef. In the United States, plans are being developed toward educating the American consumer to know and demand good beef

he public press proposes that similar work hould be done in Canada, the general view eing that it is a consuming problem. It is onsidered that, if we can get the housewife o know good beef and to ask for it, this will olve our difficulty. With all due respect, it vill not. It is true that poor beef is being ffered in the butcher shops but we will ever get greater consumption until we have etter beef to sell, even as, to the Canadian rade today, we are furnishing better eggs, etter lamb, better wool and better hogs. 'art of our beef problem, for instance, is vhat to do with the by-products of the dairy ndustry, with ill-fed calves and cast-off ows. The marketing of trash of this kind nvariably curtails the consumption of beef nd the improvement of this product, as it ctually has been improved in Holland and ther European countries, is part of the work ve have to do.

Now we have come to the place where we nust ask—What are we going to do about t? We have just said that the problem, rimarily and fundamentally, is one of proluction. Acording to the orthodox view, herefore, this is a matter which the provines should deal with, while the Dominion hould have nothing to do with it. If, accordng to the generally accepted view, the Domnion is to deal with marketing, while the 'rovinces concern themselves with producion, then the whole question of cattle imrovement is a responsibility which lies at he door of the Provinces. Is this a sound onclusion? If I bring into the open this ld question of Provincial rights as against 'ederal interference, it is because of the coniction that, unless we are willing to face acts as they are and base our future policy pon what these facts disclose, we shall never et very far. I am convinced that our catle problem is one of Dominion-wide interst, just as much as the questions of hog and f sheep improvement and I am equally coninced that, until we get over this old idea f trying to divorce our production policy rom our marketing system, we cannot make atisfactory progress. You may say that his condition does not apply in New Brunsvick. It does. I know that J. K. King and im Bremner work together like two brothers. know also that G. R. Wilson and Leslie Vood work hand in hand, and so it should e. I know that progress has been made in New Brunswick towards this end that is more than satisfactory, but we just still fall short of framing and undertaking a policy on the basis of joint discussion and of joint responsibility. It has been more or less of a tradition for Government workers to treat all such questions from an academic point of view, but our work will never lend itself to academic treatment if we are to be successful in establishing a unit business policy in the production and marketing of the products of the farm. There has never yet been a business enterprise that has worked through to a state of success where the selling system has been divorced from the production policy. Yet this is what we have been trying to do in agriculture.

I am speaking tonight, for the most part, to Government men, so that I can talk quite frankly and plainly, without fearing to tread on their toes. Therefore, let me illustrate—It has often been suggested that the application of the grading system and the payment of the premium have been the vital factors in the success of our bacon improvement campaign. They have not. I want to tell you that, had we depended upon the grading system and upon the payment of the premium alone, the work would have been dead before it had been a year old. The real reason for the success of the campaign was that the gospel was carried into the country districts where demonstrations were given as to just what was required. The farmers were shown sides of bacon and comparisons were made between "Selects" and "Thick Smooths". They were thus enabled to visualize the situation so that they were convinced that the campaign was commercially sound and that, by joining forces with the policy of the Provincial and Federal Governments, they would be better enabled to put hog production on a permanent business basis. Do you see what that means? It required the bringing together of Federal and Provincial work such that one policy dovetailed into the other and that there was no break between the two. Yet we say that production belongs to the provinces and marketing work to the Dominion. If this principle, therefore, is to apply, our progress is going to be so seriously limited as, in great measure, to negative the full effects of the work that has been undertaken in the past ten years. What I want to see now is that

the province and Dominion shall sit down together and formulate a major production policy where province and Dominion are so associated as to be practically on a fifty-fifty basis. If, on the other hand, we are to follow othodox methods and the province limits itself to a plan organized apart from the policy that is undertaken by the Dominion, we cannot but have dissension between the two Departments. Instead of formulating a uniform policy to meet the situation, we shall have one province competing with another and, what is even more vital, we shall have entire lack of coordination between the production policy of the province and the marketing policy of the Dominion as reflecting the requirements of consuming demand. We have come to a point in our history where this sort of thing will not work.

I have been impressed with the view that the time is coming when we must shift old standards and make new ones. I have been impressed further with the fact that farmers today do not want to be troubled as to who does this work—the province or the Dominion. All they want to know is what to do. They ask leadership as to the methods to be used. There has not, I think, ever been a time in history when farmers have been more ready to follow a wise lead in the development of their various activities than they are today. This, I think, is because they have realized the value of what has already been done.

Again let me illustrate—When one travels through the country, one is impressed with the fact that, notwithstanding all the work that has been done, there is still something wanting as regards the management of the average farm in the progressive adherence to business principles. How a community will respond, however, to wise direction is worth while referring to in developing our argument. Six years ago I visited a particular district in Northern Manitoba. It was a foreign settlement—a settlement of Ukrainians. At that time there was little evidence of progress of any sort whatever. They were trying to sell four or five year old dairy steers that looked to be all horns, heads and legs. There were a few lambs that were a disgrace to any community. There was almost an entire absence of poultry and pigs. The farmers were trying to make a living out of wheat in a country that was not suitable for wheat growing. Three elevators at the railway centre suggested the production policy of the district and indicated its major source of revenue. From a business point of view, the policy of the community was dead wrong and the local bank had practically lost all confidence in the centre as a business risk.

As a result of our visit, a man was secured—a young Ukrainian who had attended the Agricultural College and he was given the task of reorganizing that community's production activities. At first his work was viewed with suspicion but he quietly went about explaining to the farmers what was needed to put their farms on a paying basis and how to go about it. Last summer I again had the opportunity of visiting this neighbourhood and this time I saw groups of pigs that were just as uniform, just as true to type and just as fine examples of high grade selection as could be found in Prince Edward Island, in New Brunswick or in Nova Scotia. Calves were being sold as veal, selling for almost as much per head, at from six to eight weeks of age, as the five year old steers were sold for six years ago. The elevators were pretty nearly empty but there were fine poultry houses on every farm and the returns from milk and butter and cream provided a weekly revenue which had literally turned failure into prosperity. There had been a reorganization of the whole business system and the bankers now regarded the farmers as good business risks. The farms were prosperous, youngsters were going to school and there was comfort in the homes.

Now, why have I given you this illustration? For this reason—that the same experience might be made to apply to any community in New Brunswick where old practices are still being followed and where farms are still being managed without business system. I need not tell you of the cows that are still giving less than 4,000 lbs. of milk, and of hens that are producing under 100 eggs per year, nor of lambs that are still being marketed with long tails. Now, what I am asking you to do is to go right to the heart of this community problem, to familiarize yourself with local needs and then to formulate a unit policy as representative of both Governments and of working it out with

the farmers themselves until their farms are put on a paying basis.

We talk about different policies and propaganda as being the panacea for our agricultural difficulties and we discuss tariffs, rural credits, reduction of freight rates and so on, as the solution to our problems. These, however, are not the remedies. I want to tell you, gentlemen, that, while these may assist, to a certain extent, in solving some of our difficulties, they will never get to the heart of our business problem. Whether you agree with me or not, think this thing through and see if you do not find that the way to improve is through the reorganization of farm practices, community by community, and that all other measures are nothing but superficial palliatives in comparison with this. We hear a great deal these days about Maritime rights but I am confident that the people of the country are even now thinking ahead of a great deal of the discussion that is taking place in committee rooms and in the press. Growing out of work that has already been done, the farmers are assured that their own future is bright. They are confident as to what they can do and what they have done has already surprised the whole province. Given now wise leadership, they will solve for you the whole question of Maritime rights.

New Brunswick, at the present time, is in a position that is almost unique. Granted that progress is necessary, the farmers of the province have never been more willing or open in their attitude toward the working out of progressive policies. The responsibility, therefore, lies with our two Governments to formulate plans which will adequately meet this situation. I would again refer to the fact that our problem is one of production. What we need, therefore, is that New Brunswick shall join up with our national programme, since we cannot afford to allow any local or provincial competitive factor to limit or weaken our National Export Policy. While one province competes with another, progress breaks down and we have had too much of this condition in the past. If this is to be an exporting country, every province must be an exporting province. We must all agree, therefore, to a united plan in doing our work. There is still a great deal of independence, of individual jealousy, not to say stand-off-ishness, as between one group of workers and another. This is not necessarily due to the men themselves, since I believe there is no more public spirited group of men in the country than those engaged in agricultural work. Unfortunately, however, they are still working more or less individually and not to a common end. While this condition exists, they are not doing the best either for themselves or for their country. Give these two groups of men a common objective, to which each contributes his share, and anything can be acomplished. Take these groups of men, make them a unit, break down the barriers of political difference, encourage them to formulate a uniform plan of work, and what do you get? Just what they accomplished in the final bringing together of all forces into one unit at the end of the war. You will develop an army of men which no problem, no difficulty, can withstand. The ambition is there, the interest is there and all we need now is the final push to put this issue over the hill.

Naturally, the initiative must lie with New Brunswick itself. If you agree with my statement that our problem is one of production, you will recognize that, under our old division of prerogative, the Dominion must hesitate before trespassing too far upon Provincial rights. The cordiality, however, that has existed between the two Departments in connection with the work in this province makes one bold to invite a final and comprehensive survey of Agricultural Policy. If there are still barriers that keep us apart, now is the time to face this question. A unique opportunity offers, at the present moment, of coordinating agricultural work such that we may tackle at last the major problems of farm management, first of all, in relation to individual farm returns and then in relation to National Export Policy. Increasing the revenue from cattle is at the centre of the matter. Let it serve as the basis of establishing once and for all Provincial and Federal cooperation in a policy which will unite all forces in contributing each its full share to the success of the business of each individual farm and to the development of our national agricultural industry.

In closing, I should like to make reference to an impressive incident that occurred

just following the war. During the Peace Conference, a situation arose when those who were engaged in the work found that personal prejudices and national interests were keeping them apart: when Britain, Italy, France and the United States were failing to come together in solving the peace problem. It looked like a breakdown and a disruption of the plans that were working toward settlement. Many had become discouraged, even heartbroken, because of this condition. Just at this juncture, there appeared one morning in a Paris Sunday newspaper an editorial entitled "Pisgah or Sinai"? May I recall to your minds that Mount Pisgah was the mountain top from which Moses viewed the Promised Land — the mountain of disobedience. Because of what he had done, he was allowed only to look, not to enter. On the other hand, Mount Sinai was the mountain where the law was delivered and written in table of stone. It represented obedience and fulfilment of promise. The editorial said that good folk were accustomed on the Sabbath morning to take a day's journey and the invitation was offered on this morning to ascend a mountain top, it being given to them to choose between Pisgah and Sinai. It was explained that there had been failure to get together owing to personal jealousies and national prejudices. It was pointed out that Lloyd George and Clemenceau and Orlando had done fine work but that in some subtle way the hopes of the people were centered on President Wilson. It was suggested that he was the one to do the leading and that, if he failed to live up to the ideals to which he himself ha given expression, he would be the one who the people would decry. For him the choi lay between Pisgah and Sinai. If he faile to rise to the standard of expectation th the people had of him, he might see t Promised Land but would never be able enter. On the other hand, if he lived up his own ideals, if he lifted himself abo the common level of jealousy and nation selfishness that surrounded him; in othe words, if he travelled to the mountain to of Sinai—the mountain of obedience—not ing could keep him from entering the lan of promise and he would carry the natio with him.

I feel that we have come to the partin of the ways in our agricultural work in Ca ada. We may still continue on a commo level, hedged about by personal jealous and restricted in our efforts by the inertia orthodox procedure or the standoffishness political considerations. This is the wa of Mount Pisgah and the end—retrogressio and disillusionment. On the other han we make take advantage of the opportuniti that offer. We may follow the lead of new era as represented in our Boys' an Girls' Club work. We may allow ourselv to be challenged by the thought of the se vice we can render to the rising generatio We may get together in a campaign of wo for Canada that will carry the people wit us and help them over the stile. This is th way of Mount Sinai and the end is th promise which remains to those who a obedient unto the heavenly vision.

EDITORIAL NOTE:—Readers of the foregoing address will be interested in knowing that at the Annual Convention of the Canadian Society of Technical Agriculturists, to be held at Ottawa, from June 23rd to 26th, one entire afternoon is to be devoted to an informal discussion on the question of coordination of agricultural policy. Dr. J. I Grisdale, Deputy Minister of Agriculture f Canada, will preside and representatives fro Federal and Provincial Departments of Agr culture and Agricultural Colleges have bee invited to lead in the discussion. This wi be on the afternoon of June 25th.

The Life History of the Saskatoon Sawfly.

(*Hoplocampa halcyon* Norton) *

R. D. BIRD

Dominion Entomological Laboratory, Treesbank, Man.

While carrying out investigations on the nsects attacking our cultivated and native ruits in the summer of 1924, it was found hat the fruit of the Saskatoon (*Amelanchier picata*) was severely injured by small sawly larvae. As the saskatoon is probably used n the Canadian Prairies as a preserve, more han any other native fruit with the exception f raspberry and as the sawfly might also ttack cultivated fruits that are being introluced, a study of its life history was underaken in the summer of 1925.

I acknowledge with pleasure the help reeived from my chief, Mr. Norman Criddle, Entomologist in charge of the Treesbank aboratory, in preparing the following notes, nd that from Mr. H. L. Viereck, of the Enomological Branch, Ottawa, in the identifiation of the sawfly. This sawfly was originlly described in 1861, by Norton (1), as *Selandria halcyon*, but in 1911 was transferrd by Rohwer (6) to the genus *Hoplocampa*.

It is probably found throughout the range f the saskatoon. Rohwer (6) gives records rom Canada, New York, Washington, D.C., nd Clementon, N.J., and Norton (3) records t from Maine, Massachusetts, Maryland, and Saskatchewan; it has been taken in Manitoba t Aweme, Douglas, Baldur, Birtle, Steep Rock, and Brandon.

In Manitoba *H. halcyon* has been found atacking only *Amelanchier spicata*. Norton (3) ays "taken for successive years in Baltimore, y Mr. Uhler, on *Amelanchier canadensis*" nd Konow (4, 5) also gives *A. canadensis* as food plant.

The injury to the saskatoon by this sawfly s brought about by the feeding activities of he larvae in the fruit. The larva on hatching mmediately eats its way into the center of he growing fruit. As soon as one berry is aten to a shell, it leaves it and enters anther in the same cluster. Usually three berries, but sometimes four are devoured, beore the larva becomes full grown and drops o the ground.

In the vicinity of Aweme, Manitoba, the saskatoons were damaged to the extent of 25 percent in 1924 and 35 percent in 1925.

Most of the data concerning the life history and behaviour of the saskatoon sawfly were obtained by observing the insects out of doors. The mating and oviposition habits of the adults, were studied in a small cage, made by covering a mica chimney at one end with cheese cloth and placing it over a fresh branch of saskatoon flowers in a tumbler of water. Sphagnum or cotton was placed in the water to prevent the insects from drowning. Adults readily made themselves at home in this cage and their activities were easily observed. It was found that the branches could not be kept alive long enough for the eggs to hatch; hence all further observations were carried out on the bushes outside.

Description of Life Stages

Egg (Fig 1a). The egg is elliptical in outline, but is not symmetrical, as one side is somewhat flattened. In cross section it is circular when removed from the plant tissues, but in its normal position it is slightly compressed by the pressure of the tissues. The chorion is membranous, white, shining and flexible. The average measurements when new-laid are, 0.75 mm. in length by 0.39 mm. in width.

The egg is deposited in a sepal of a saskatoon flower, usually under the inner epidermis, but sometimes under the outer. Normally only one egg is laid in a flower, but sometimes two or three occur in which case all perish but one.

The developing embryo can be seen clearly through the chorion, which enlarges considerably from the pressure within. In the spring of 1925 the eggs hatched 10 days after being laid. Possibly in the average season this period may be somewhat shorter, as the weather in 1925 was cold and rainy.

* This paper has been submitted to the University of Manitoba in partial fulfillment of the thesis requirements for the degree of Master of Science.

Figure 1. a, egg; b, egg deposited under the outer epidermis of a Saskatoon flower, showing saw cut; c, part of a Saskatoon fruit cut away to show a first instar larva eating into it.

LARVA (Fig. 2). To determine the number of instars of the larvae, the infested berries were examined daily. After moulting, the head capsule could usually be found in the pile of excreta extruded from the entrance hole, but the remainder of the cast skin was missing, probably having been eaten.

The instars may be distinguished by the pigmentation of the dorsum of the seventh, eighth, ninth and tenth segments of the abdomen and by their size. The thoracic legs are short and are composed of a thick basal portion, three segments and a terminal claw. The antennae are short and four segmented. The labial palps are composed of two, and the maxillary palps of four, short segments.

Immediately upon hatching the larvae eat their way into the center of the fruit, always entering between the sepal in which the egg was laid and the remains of the pistil.

In the *first instar* (Fig. 2a) the body is translucent, white and only slightly wrinkled. At first there is no pigmentation, but as the larva grows definite colour develops. The head and labrum become light brown while the mandibles though brown are of a darker shade. The maxillae and labium remain colourless while the dorsum of the ninth and tenth abdominal segments become black. Newly hatched larvae measure 1.4 mm. in length and when fully grown, attain a length of 3 mm.

After eight days the larvae moult, by whic time they have usually devoured about on third of the berry. The excreta, which voided through the entrance hole makes qui a conspicuous pile on infested fruit. In som cases, when the fruit attacked is small it eaten to a shell at the end of the first insta and the larva leaves it to enter a second in mediately after moulting.

In the *second instar* (Fig. 2b) the head blackish, but the labrum is only slightly pi mented. The thoracic legs, which before we colourless are now grey. The dorsum of th eighth, ninth and tenth abdominal segments black, otherwise this stage is as in th preceding instar. The length increases fro 3.2 to 5 mm. when ready to moult.

After a period of three days, moultin takes place for the second time. The larva have now devoured all but the skin of th first berry and entered the second, in a cases between the remains of a sepal and th pistil.

In the *third instar* (Fig. 2c) the head an labrum are brown, the mandibles blackish an the thoracic legs are not pigmented. Th dorsum of the seventh, eight, ninth and tent abdominal segments is black. Otherwise th stage resembles the preceding instar. Th length increases during this instar from 5 to 6mm.

From now on the duration of the insta varies considerably, according to the si

Figure 2. a, b, c, d, e, instars one to five of the larva of the Saskatoon sawfly (*H. halcyon.*). Below each is shown the characteristic pigmentation of the dorsum of the last abdominal segments.

of the individual fruit, which influences the vitality of the larva attacking it. The third and fourth instars usually last for five days, but may continue for ten. In either case a third berry is entered, this time anywhere on the side, or in the old flower scar.

In the *fourth instar* (Fig. 2d) the head is of a lighter brown than in the preceding. The dorsum of the ninth and tenth and part of the eighth abdominal segments is dotted lightly with black. The body is stouter but otherwise the characters are as in the preceding instar. The length increases from 6.2 to 7.2 mm.

The *fifth instar* (Fig. 2e) has all of the dorsum of the eighth, ninth and tenth abdominal segments dotted lightly with black. Otherwise the appearance is as in the fourth instar. The length increases from 6.5 to 9 mm.

The third fruit is now eaten to a shell. The larvae crawl out through the entrance holes, drop to the ground and, depending on its hardness, burrow from one to three inches below the surface. Here they spin a brown cocoon and enter a resting state before pupating the following spring. The last larva had entered the ground by June 24 in 1925.

At all times and particularly during the last two instars the larvae are very active when removed from the fruit.

The Cocoon, to which particles of earth adhere, is made of a brown silk spun so that it has a papery texture. It is oval in outline and slightly greater in diameter at the cephalic end. It measures 4.5 to 5 mm. in length and 1.8 to 2 mm. in width.

The Pupa is of the type where the appendages are free, but held close to the body. Male and female pupae can be differentiated by their size and external genitalia. The pupae are slightly smaller than the adults.

On May 5, 1925, a number of cocoons were dug up from under saskatoon bushes, that had been heavily infested in 1924; some of these were opened and were found to contain larvae with the head and thorax bent almost at right angles to the body in preparation for the pupal moult. From the remaining cocoons adults emerged on May 11. Hence the pupal period must be very short.

The Adult is a small yellowish insect, with a large black area on the tergum, the size of which varies with the individual and the sex. In the male it covers all of the tergum except the apex of the abdomen as well as the thorax. In the female the distribution of this black colour is not so great. The antennae and a small patch about the ocelli are also black. Length 3.9 to 4.1 mm.

The time of emergence of the adults varies with the weather conditions of the spring.

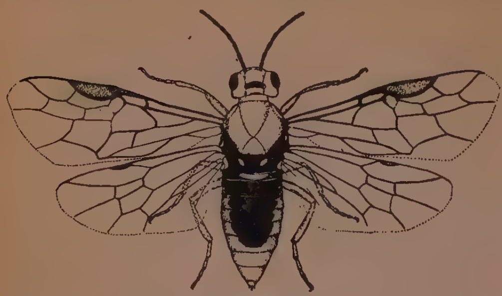

Figure 3. The Saskatoon Sawfly (*Hoplocampa halcyon* Norton, *female*.

Usually they appear in the later part of May, but the exact date may extend over a range of three weeks or a month, according to the progress of the season and always coincides with the opening of the first flowers of the host plant. In 1925, specimens were taken on some early saskatoon flowers in a warm hollow by the Assiniboine river on May 11, but the main body of the sawflies did not appear until May 18, when the majority of the saskatoons were coming into flower. By May 29, the saskatoons had practically finished flowering and only a few sawfly stragglers were observed. In 1924 emergence was about three weeks later, due to a late spring.

The sawflies are very active in warm weather, but during cold and wet periods they become sluggish and hide in the flower clusters, or beneath the leaves of the host. When swept into a net they feign death for a few seconds and then crawl upwards. While moving about, the antennae are kept in constant vibration. In confinement they show a strong negative reaction to gravity and positive reaction to light. By making use of their negative geotaxis, a large number may be collected in an inverted glass tube.

The adults, particularly the gravid females, were observed to feed eagerly upon the pollen and nectar of the saskatoon, at frequent intervals.

Mating was frequently observed and found to take place in a manner similar to that of *Profenusa collaris* (8).

Oviposition was observed a number of times, always during the warmest part of the day. When about to oviposit the female crawls upon the calyx of an open saskatoon flower, with the body at right angles to the long axis of the flower. She then bends the tip of the abdomen down and feels about with the hairs at the tip of the apical plates of the saw sheaths. When a suitable place is discovered the sawfly secures a firm foothold and proceeds to insert the saw. The wings are folded while thus engaged and the antennae which were previously vibrating, are bent ventrally at a slight angle and become motionless. The abdomen then makes a series of gentle movements as the saw is forced in and under the epidermis. When it is in to its full length it is swung in the arc of a circle towards the ventral surface of the abdomen then back again, so as to clear the cut. The egg is then laid and the saw quickly withdrawn. The female then retires to a flower to feed upon the nectar and pollen. After a short rest she oviposits again. Then another rest and a third egg is laid, after which she retires for a longer time, often flying to a different part of the plant and mating before resuming egg-laying. The process of making the saw cut and laying the egg takes about a minute. Eggs are laid in the flowers from the time the petals are about to unfold until the time they fall. As soon as the petals drop, the sepals curl back and harden. In this condition the sawflies will not oviposit. Hence it is only for about two or three days that the saskatoons are subject to the egg-laying of the sawfly. Judging from observations, the length of life of the adult sawflies coincides approximately with the period of flowering of the host plant, which is from 15 to 20 days.

No parasites have yet been reared, but the larvae of seversl ichneumon flies were found in the cocoons. All died, however, before emerging. Ants prey to a small extent on the adults and larvae, when migrating, and have been observed to catch the adults, when they alight. Birds undoubtedly feed to a limited extent on the adults. The greatest means of natural control is brought about by meteorological conditions that prevent the maturing of the saskatoon fruit, a late frost being the most effective.

No experiments have yet been carried out on the control of this sawfly. Adults could probably be killed by contact spraying, with a nicotine oil solution, in the early morning when still sluggish, or by a poisoned sugar solution in the warm part of the day. Spray-

ing with arsenic, when the larvae are migrating (9) would kill many. If the sawfly attacks cultivated fruits, thorough cultivation of the soil under the bushes in the fall (1) should kill many hibernating larvae.

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The Carbon-nitrogen Ratio in Soils and its Relation to the Decomposition of Organic Matter and Nitrogen Changes.

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In a study of soils we are studying a system which is never in a state of equilibrium. Like the life which it has sustained and nourished the soil has been changing and evolving. The soil of today is not the soil of yesterday nor will it be the soil of tomorrow. It is never still. It is continually seeking a mechanical and chemical adjustment with the forces which surround it or are active within its precincts. Such equilibrium it never attains and thus the evolution goes on and on. It is this continual change and this endless response to environment that makes soil useful to plants; but it also adds greatly to the difficulties which beset a soil investigator at every turn.

One of the most changeable and yet one of the most constant relationships in the soil is that which exists between the soil carbon and soil nitrogen. This we speak of as the carbon-nitrogen ratio. It has been my pleasure and privilege to do some little investigation of this phase of soil study, and I think it is well worthy of more detailed study. There exists an enormous quantity of literature on each constituent, organic matter and nitrogen, but a search of literature reveals very little on the relation between them—the C-N ratio. Previous investigations by Alway of Minnesota (1) (2) have shown that the ratio of organic C. to N. varies only from 11.2 to 13.6:1 and increases with depth. In Russia Kossovitch (3) found it to be 11.6 to 1. Under cultivation the ratio drops, Alway (4) showing that after 25 years cultivation it dropped from 10.9:1 to 10:1. Blair and McLean (5) found that the carbon content of land allowed to run wild, slowly increases, while the nitrogen remains fairly constant. As a result the ratio widens. Russel (6) points out that on cultivated soil 95% of the carbon applied is used up in a year and only 85% of the Nitrogen. Thus the ratio tends to narrow even when manure is applied. Hall's work at Rothamsted shows the same result (7).

Other investigators have also touched the subject but generally indirectly. The general conclusion seems to be that the C:N ratio averages about 10:1 and such condition is a state of equilibrium where if one constituent is increased in concentration it causes a disappearance of the other.

But the relation is not due to a well defined chemical reaction between these substances. It is not so simple as that, but is almost entirely due to bacterial activities.

Before we discuss the relation of the C:N ratio to the decomposition of organic matter and nitrogen changes, let us examine the ratio existing in well defined soil types and see what differences occur. I will not go into detail as regards the method of determination of each except to say that the Gunning Kjeldahl method modified for nitrates was used for nitrogen and the organic carbon was determined by the Parr CO_2 method, obtaining total carbon, subtracting the carbonate carbon resulting in the organic.

Ten soil types were analyzed, using from two to twelve samples of each type, the C:N ratio varying from 7.45:1 to 16.60:1. From these results we see that the ratio has much wider variations than previously stated.

There are many factors which influence this relationship, but their action is more or less ill defined. One of these is the total calcium in the soil. If we arrange them in order of the total amount of CaO present we have this relation:—

	CaO below .5%	.5% CaO to 1%	Above 1%
C:N	11.95:1	11.89:1	13.92:1

Since these soils are all deficient in carbonates we cannot place much dependence on these results, but the probability of such relation is interesting.

We cannot take the time to discuss in detail the different factors affecting the C-N ratio because there is another very interesting feature of this relationship. What will happen if we suddenly narrow this ratio to say 3:1 or widen it to say 20:1 or wider still? This has a very practical application in the use of strawy manure, straw, long stubble or green manures.

We at this station have not yet done much work in this particular field except a limited amount of preliminary investigation done in ordinary tumblers. This was done with the object of taking the work afield this year.

In this respect the investigations of others will prove interesting. Waksman (8) of New Jersey points out that for every hundred pounds of carbon broken down by bacteria, fifty pounds are assimilated. To assimilate this carbon, approximately three percent of nitrogen is required. As a result there must be a supply of nitrogen in order that the bacteria, moulds and actinomycetes may utilize the carbon and this should be above three percent of the total carbon content. If less the nitrogen must be secured from some source and the nearest available source is in the nitrate content of the soil. If the nitrates are used up it follows that the growing crop cannot secure its nitrogen requirements and suffers from partial nitrogen starvation. If, however, there is three percent or above in the organic matter, that is sufficient to supply the forms of life breaking down the cellulose and the nitrates will not be used. Thus the growing crop will not be affected.

Investigations along this line have been carried out at the New York Experiment Station, Geneva, by Conn and Collison (9), at Brigham Young University by Martin (10), by Anderson (11) at the Central Swedish Experiment Station, Viljoen and Fred (12) of Minnesota, Murray at Washington (13), and others. The explanation of the action of the cellulose, however, is due to Waksman of New Jersey.

Martin from his work draws the following conclusions:—

1. The decrease of available nitrogen (nitrates) for crop growth is directly proportional to the amount of cellulose added.
2. With increasing amounts of cellulose added the crop growth was proportionately reduced.
3. After twelve months have elapsed the depressive influence will have passed away and a beneficial action manifests itself.

This seems to be in keeping with the majority of findings and I think we may safely

accept the explanation that such harmful action is due to a widening of the carbon nitrogen ratio. Collison and Conn (9), however, claim that some of the depressive influence of straw turned under is due to the formation of toxic organic compounds such as dihydroxy stearic acid, vanillin, cumarin and salicylic acid formed under decomposition of the straw.

Now as to the practical application. Our farms and market gardens have not the manure supplies which were available a few years ago. We must keep up the organic matter in our soils in some way or other. Can we utilize straw, alsike chaff, sweet clover straw from seeded plants (useless for feed) or green manure crops? What effect will they have when ploughed under? How can this effect be overcome? Can we treat this straw or other material before ploughing to overcome any toxic action?

These are the problems which are confronting us and we have already plans under way to solve at least some of them. It is a generally accepted fact that if the nitrogen content of the material utilized is increased to above three percent of the total carbon content, its depressive action will be lessened if not overcome. This we have proven by tumbler work and are taking it afield this year.

Another phase of the same problem is in the muskeg soils of Northern Ontario. Although these appear in good condition, nitrates applied give good results in crop growth. The explanation is probably the same as before, due to increased decomposition of the cellulose with a resulting increase in available plant food. Anderson in Sweden (11) calls attention to the fact that the rate of decomposition of cellulose is dependent on, if not proportional to, the total nitrogen content.

The carbon-nitrogen ratio is of importance then in practical agriculture and any sudden disturbance of the natural state of equilibrium tends to bring about conditions which may be detrimental to crop growth. On the other hand we can hasten by certain means the amelioration of the conditions which bring about such effect.

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Some Pollination and Cytological Studies of Sweet Clover.*

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Sweet Clover is becoming recognized as one of our standard forage plants for the Canadian West, and is regarded by McRostie (7) as one of the two most important cultivated legumes for that region. It is being used as a soil improvement crop in many regions. The rapid increase in popularity since sweet clover was first introduced only serves to emphasize its importance.

In searching through farm and technical publications one finds that many studies have been made to furnish information regarding rates and dates of seeding, proper rotations, stage of cutting and other cultural methods. There are few, if any, records of methods for improving this crop. The great need is to combine quality with the characters of yield and hardiness and seeding properties commonly found in sweet clover.

A knowledge of the mode of pollination is necessary in choosing the correct methods of breeding any crop. The question of whether the common species of sweet clover are naturally selfed, naturally cross pollinated or whether they are all pollinated alike is still an open one. A study of the amount of natural crossing for inter and intra specific classes would answer the question beyond a doubt. This is best accomplished by a controlled experiment on the inheritance of a simple character. Desirable material was not available for the test, so a study of pollination was undertaken.

Previous Studies

It is of interest to note Darwin (3) includes *M. officinalis* in his list of plants, sterile in the absence of insects. Knuth (2) and Muller (2) believe that self-fertilization of this crop is not apt to occur.

Kirchner (2) concludes that self pollination occurs regularly in *M. alba* and *M. officinalis*. It should be noted that this is the only reference found where seed was obtained from *M. officinalis* when protected from the visitations of insects. Coe and Martin (2) accepted Kirchner's viewpoint with regard to this crop.

There seems to be no work on the relation of chromosome numbers to the breeding behaviour of this crop. Casteller (1) reports a count of 8 chromosomes in the haploid condition for *M. alba* and *M. alba annua*.

Method of Conducting Experiments

The flowers of sweet clover naturally set a high percentage of seed. It follows that this crop is either spontaneously self-pollinated under the given environment or is more or less cross-pollinated. Wind and insects are the natural agents of cross-pollination. Two pollination experiments were outlined to control these natural agents of pollination. Experiment 1 was made at Manitoba Agricultural College on plants in row tests during the summers 1923 and 1924 and gives a comparison of the seed setting ability of racemes enclosed with and without bees to the normal checks. An outline of this experiment is given in Table I.

Table I. An outline of Experiment I made at the Manitoba Agricultural College to Compare the Seed Setting Ability of Flowers Enclosed with and without Bees to the Normally Pollinated Checks.

TEST	TREATMENT OF FLOWERS
(Check)	Exposed, no treatment
(C-B)	Caged, no bees
(C B)	Enclosed with bees, replaced daily during the flowering period.

In Experiment I, the most vigorous leafy plants were selected for the work. Small wire cages covered with tarlatan were used to control the visitation of insects. Bees were

* From a thesis submitted to the faculty of the graduate school of the University of Minnesota in partial fulfillment for the degree of Master of Science.

Figure 1. Method of protecting flowers from cross-pollination by wind and insects, through enclosing the flowers in parchment paper bags. (University Farm, St. Paul, Minn., 1925).

btained from hives, situated approximately ne quarter of a mile from the clover plot nd were washed in luke warm water to re- nove any pollen that might be adhering to hem. In 1923 ripe seeds were counted af- er harvesting, but in 1924 a count of the ully formed pods was used.

The seed from the 1923 test was grown at he Manitoba Agricultural College and that rom the 1924 test at the Minnesota Experi- nent Station. Observations on height, fol- age color and any other differentiating char- cters were made on each progeny.

It was suggested to the writer that even hough insects were excluded cross pollina- ion might occur by the agency of wind. 'herefore, Experiment II was made at the linnesota Experiment Station in 1925 and ives a comparison of seed setting of racemes nclosed in parchment paper bags to the ormal checks. For outline of this experi- nent see Table II.

'able II. An outline of Experiment II made at the Minnesota Experiment Station to Compare the Seed Setting Ability of Flowers Enclosed in Parchment Paper Bags to the Normally Pollinated Checks.

TEST	TREATMENT OF FLOWERS
heck	Exposed, no treatment.
C-B,W)	Enclosed in parchment paper bags.

In Experiment II, fifty plants of each species, *M. alba*, *M. alba annua* and *M. officinalis* were tested. A flowering branch of five or six racemes on each plant was labelled C-B,W. and enclosed in a parchment paper bag. A branch in the same stage of maturity was tagged and left exposed for a check (See fig. 1). In this test counts were made of the pods as soon as they were fully formed.

Experimental Results

Pollination Experiments with M. alba. In the study of the mode of pollination of this species the two experiments, previously outlined, were carried out. In Experiment I a comparison is made of the seed setting ability of racemes enclosed with and without bees to the normal checks and is made to find out whether bees play a part in the pollination of sweet clover. In Experiment II a comparison is made of the seed setting of racemes enclosed in parchment paper bags to the normal checks. In this experiment cross-pollination by both wind and insects is prevented so that the seed obtained in parchment paper bags is produced by spontaneous self-pollination.

The data obtained from Experiment I, carried out at the Manitoba Agricultural College, are presented in Table III.

Table III. Comparative Results of Seed Setting in White Sweet Clover in Experiment I at the Manitoba Agricultural College.

Test	Total Number of Flowers 1923	Flowers 1924	Seeds 1923	Pods 1924	Flowers setting seed in per cent 1923	1924	Average
(Check	218	735	165	517	75.68	70.34	73.01
(C-B)	222	702	125	317	56.30	45.15	50.73
(C B)	216	775	205	511	94.90	65.93	80.41

When insects were excluded, 50.72 per cent of the flowers set seed for a two-year average. This proves that white sweet clover is capable of being pollinated without the aid of insects. It is noticeable that checks, which were naturally open-pollinated, produced on the average only 22.29 per cent higher than protected racemes. When fresh bees were introduced daily the power to set seed was materially raised even over the open pollinated checks to the extent of 7.4 per cent. As the bees were brought to the sweet clover plot from a distance and washed so as to remove adhering pollen it would follow that the stimulation in seed setting of 26.69 per cent over those racemes protected from the visitation of insects was due to the action of bees and not to the action of the foreign pollen. It would seem from this that the enclosure in nets in this experiment had no deleterious effects on the ability of these plants to set seed and that this particular character is dependent on the proper manipulation of the flowers.

The studies carried on at the Minnesota Experiment Station in Experiment II, in which a comparison was obtained of seed setting in parchment paper bags with the normal checks gave the results presented in Table IV.

Table IV. Comparison of the Ability of White Sweet Clover to Set Seed when Enclosed in Parchment Paper Bags to the Normal by Pollinated Checks in Experiment II at the Minnesota Experiment Station.

Test	No plants in test	Total No. racemes tested	Total No. seed set	Average per raceme
(Check)	50	147	2046	13.9
(C-B,W)	50	230	1531	6.6

Flowers inclosed in vegetable parchment bags set an average of 6.6 pods per raceme compared to 13.9 pods per raceme on th exposed checks. In many cases seed fro treated pods was shrunken. Seed from th checks of these plants was also affected. Th condition was due most probably to hot d weather conditions that prevailed about th time seed was setting. The fact that a larg percentage of seed set when the flowers we protected from cross-pollination by wind insects under extreme artificial condition shows that white sweet clover is capable self-pollination.

General observations were made in 192 on the breeding behaviour of ten progeni of ten plants used in 1923 and 1924 pollina tion tests. The seed from plants of 1923 ex periment was sown at the Manitoba Agr cultural College in 1924. The seed from th 1924 test was sown in 1925 at the Minneso Experiment Station. In each progeny th plants from seed of racemes protected fro insect visitation was labelled and grown se arately from the plants of the open pollina ed checks.

The characters of plant color and heig were very noticeable. No apparent diffe ence was noted between the plants from ope pollinated seed and plants from seed a parently selfed. In general all plants of family were uniform for the characters question. The pollination tests indicate th ability of white sweet clover to self-fertili in the absence of both wind and insects an under extreme artificial conditions. Thi would appear to show a high degree of n tural self-pollination of this species.

Pollination Experiments with M. offi cinalis. The same two experiments we carried on with yellow sweet clover as wi the white species. In Experiment I th pollination by insects was controlled and Experiment II the pollination by both wi and insects.

The data obtained in Experiment I for th species are given in Table V.

Table V. Comparative Results of Seed Setting in Yellow Sweet Clover in Experiment I at the Manitoba Agricultural College.

Test	Total Number of Flowers 1923	Flowers 1924	Seeds 1923	Pods 1924	Flowers setting seed in per cent 1923	1924	Average
(Check)	235	558	142	506	60.42	90.68	75.55
(C-B)	213	537	3	16	1.40	2.97	2.18
(C B)	204	550	35	182	17.15	29.40	23.27

Two and eighteen hundredths per cent of the flowers protected from the visitation of insects set seed, while on the exposed check 75.55 per cent of the flowers set seed. On those racemes which were enclosed with bees during the flowering period 23.27 per cent of flowers set. These experiments show that for yellow sweet clover comparatively few seeds set on protected racemes and indicate that this character is over-sensitive to enclosure in nets or that cross-pollination is necessary for a successful setting of seed.

The reaction of yellow sweet clover in Experiment II when enclosed in parchment paper bags was even more striking than when enclosed in tarlatan cages. The results are given in Table VI and show that out of the fifty plants treated three plants set one pod each while the checks produced an average of 27.35 pods per raceme.

Table VI. The Comparative Results of the Ability of Yellow Sweet Clover to Set Seed when Enclosed in Parchment Paper Bags to the Normal by Pollination Checks in Experiment II at the Minnesota Experiment Station.

Test	No. Plants in test	Total No. racemes tested	Total No. seed set	Average per racemes
(Check)	50	177	4841	27.35
(C-B,W)	50	—	3	—

Similarly, as in white sweet clover, the seed from the pollination experiments was sown and observations made on the breeding behaviour of these progenies. In all, nine families were grown. Five families from seed of the 1923 pollination tests were sown in 1924 at the Manitoba Agricultural College and four families from seed of the 1924 pollination experiments were sown in 1925 at the Minnesota Experiment Station. Owing to the poor set of seed on enclosed racemes each progeny consisted of plants from seed of the open-pollinated checks. In general, the plants in each family were not so uniform as those in each family of white sweet clover. There is not sufficient data on the breeding behaviour of this species on which to base conclusions; however, the lack of uniformity in the plants of each family would indicate some cross pollination.

The inability of yellow sweet clover to set seed when enclosed so as to prevent cross pollination by wind and insects suggests two possibilities. The plant is either somewhat self-sterile or, as Kirchner suggests, is very sensitive to enclosure in nets or bags. There is an apparent difference in the mode of pollination of the yellow and white species of sweet clover. White sweet clover set 6.6 seeds per raceme when enclosed in parchment paper bags compared to .01 seeds per raceme on the yellow species. This is enough difference to suggest a modification of Coe and Martin's (2) statement that "both *M. officinalis* and *M. alba* required the same methods of pollination to set seed."

Pollination Experiments with M. alba annua. Similar studies were carried out on Hubam sweet clover as with the white and yellow species with the exception that Experiment I at the Manitoba Agricultural College was only carried on in 1924.

The data gathered in Experiment I are given in Table VII. It will be noticed that these results are very similar to those obtained from yellow sweet clover in that both species set a low percentage of seed when enclosed in tarlatan cloth cages. This test on Hubam was only carried on during one season and owing to the lateness of the crop and the short growing season free from frost in Manitoba, seed from this experiment was not gathered until after the first killing frost in the fall. It is altogether possible that this factor influenced the results.

Table VII. Comparative Results of Seed Setting in Hubam Sweet Clover in Experiment I at the Manitoba Agricultural College.

Test	Total number of Flowers, 1924	Pods, 1924	Percentage flowers set, 1924
(Check)	519	473	91.1
(C-B)	467	3	.64
(C B)	532	270	50.75

The data contained in Table VII from Experiment II do not substantiate or agree with those in Experiment I in that those racemes of Hubam enclosed in tarlatan cages were almost barren while in Experiment II almost as many seeds set per raceme as the white sweet clover when enclosed in parchment paper bags. On racemes enclosed in vegetable parchment bags an average of 4.31 pods set per raceme compared to 28.57 pods per raceme on the open-pollinted checks. This proves the ability of Hubam sweet clover to be self-fertilized.

Table VIII. A Comparison of the Ability of Hubam Sweet Clover to Set Seed When Enclosed in Parchment Paper Bags to the Normally Pollinated Checks in Experiment II at the Minnesota Experiment Station.

Test	No. plants in test	Total No. racemes tested	Total No. seed set	Average No. seed set per raceme
(Check)	50	148	4229	28.57
(C-B,W)	50	184	794	4.31

Only three families of Hubam sweet clover were grown at the Minnesota Experiment Station in 1925 from seed of the 1924 pollination test. There were only a few seeds from protected racemes so the plants grown were from seed of the open-pollinated checks.

In the three families of Hubam sweet clover no particular uniformity as to shade of foliage color was noticed, but even though there was only a comparatively small number of plants per family a decided uniformity existed as to the height of each family.

The fact that the pollination tests indicate the ability of Hubam sweet clover to self-fertilize in the absence of wind and insects and that the families from seed of individual plants were very uniform for the characters in question would appear to show a high degree of natural self-pollination for this species.

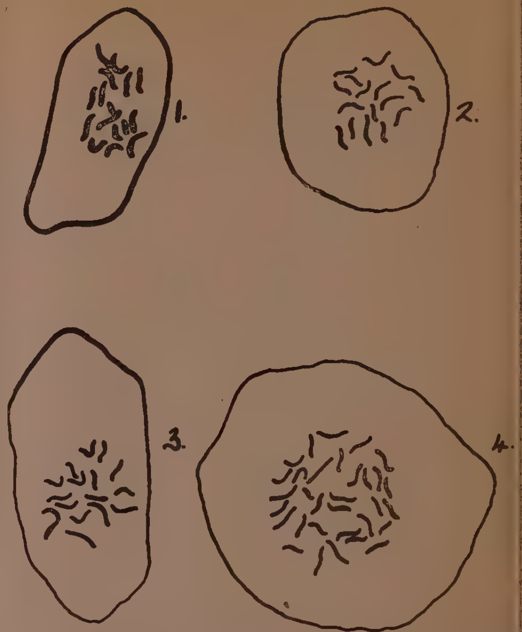

Figure 2. Camera hucida Drawing of Chromosomer Figures. (1) *M. alba,* (2) *M. alba annua,* (3) *M. officinalis,* (4) *Medicago sativa.*

Cytological Data

A preliminary study on sweet clover would not be complete without a cytological examination to ascertain the chromosome numbers of related species. A chromosome count was made of each species of sweet clover *Melilotus alba, M. alba annua, M. officinalis,* and alfalfa *Medicago sativa.*

In this study the figures obtained were prepared from root tips killed with Bouin's killing fluid, cut by the paraffin method 5 microns thick, and stained in Haidenhain's iron-alum Haematoxylin.

A count of sixteen chromosomes in the root tips of *Melilotus alba* (see 1, fig. 2) agrees with the count of Castetter who reported eight chromosomes in the haploid condition for this species. A figure of *Melilotus alba annua* and *Melilotus officinalis* shows that they also contain sixteen diploid number (see 2 and 3, fig. 2). It is of interest that each of the three species has the same chromosome number. This is not a sure proof however, of a similar origin or individuality

From time to time reports have been issued of a suspected cross between white sweet clover, *Melilotus alba*, and alfalfa, *Medicago sativa*. A careful study of such suspected crosses would probably help to solve this question since white sweet clover and alfalfa differ in chromosome numbers. Alfalfa has thirty-two chromosomes in the diploid condition which is twice the number of sweet clover.

SUMMARY

1. Pollination studies were made of the three common species of sweet clover, *Melilotus alba, M. alba annua*, and *M. officinalis*. Experiment I was made during the summers of 1923 and 1924 at the Manitoba Agricultural College. In this experiment a comparison is made of seed setting between racemes enclosed with and without bees in tarlatan cages and open pollinated checks. Experiment II was made at Minensota Experiment Station during the summer of 1925 and gives a comparison of seed setting between open-pollinated checks and flowers enclosed in parchment paper bags. Pollination by wind and insects was controlled in these experiments in an effort to find the normal mode of pollination for this crop.

2. White sweet clover set seed readily under the conditions of both pollination experiments. Progeny from open pollinated racemes of ten plants was grown separately and compared to selfed progeny of the same plants. In general all plants of a family, whether from selfed or open pollinated seed, were similar in appearance. This fact, together with the high degree of seed setting of enclosed racemes, would appear to show that under ordinary conditions white sweet clover is to a high degree self-pollinated.

3. Yellow sweet clover set very few seeds when the visitation of insects was controlled in Experiment I, and in Experiment II out of fifty plants with racemes enclosed in parchment paper bags only three plants set one pod each, while the open-pollinated checks on the same plants produced an average of 27.35 seeds per raceme. Nine families were grown from open-pollinated seed. In general the plants in each family were not so uniform as those in each family of white sweet clover. The fact that the families were not altogether uniform and the inability of this species to set seed when enclosed so as to prevent cross-pollination by wind and insects indicates that yellow sweet clover is either somewhat self-sterile or, as Kirchner suggests, is very sensitive to enclosure in nets.

4. Hubam sweet clover set very few seeds on enclosed racemes in Experiment I in 1924. Owing to the fact that this experiment was made late in the season it is altogether likely that frost interfered with seed setting under the different treatments. In Experiment II this species set an average of 4.31 pods per raceme when enclosed in parchment paper bags. This indicates the ability of Hubam sweet clover to be self-fertilized. Only three families were grown at the Minnesota Experiment Station from open-pollinated seed of the 1924 pollination experiments. A decided uniformity existed as to height and habit of growth of plants in each family. From these facts it will be seen that Hubam sweet clover reacts to the conditions of the experiment in very much the same manner as white sweet clover and under ordinary conditions appears to be self-fertilized to a high degree.

5. Chromosome counts were made of alfalfa and the three common species of sweet clover. Figures were obtained showing sixteen chromosomes in the diploid condition for each of the species *Melilotus alba, M. alba annua* and *M. officinalis*, and thirty-two chromosomes in the diploid condition for alfalfa, *Medicago sativa*.

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ACKNOWLEDGEMENTS

The writer is indebted to Professor W. Southworth for helpful suggestions during the early stages of the project and to Dr. H. K. Hayes for the many constructive criticisms during the progress of the study. Dr. Fred Griffee gave helpful suggestions in cytological technique.

CONCERNING THE C. S. T. A.

Back Numbers Wanted

The supply of certain back numbers of *Scientific Agriculture* is entirely exhausted. Any member who will send any of the missing numbers to the General Secretary will be paid at the rate of 50 cents per copy. The numbers wanted are:

Volume 1, No. 2, February 1921.
Volume 2, No. 1, September, 1921.
Volume 5, No. 9, May, 1925.
Volume 5, No. 10, June, 1925.
Volume 5, No. 12, August, 1925.

Constructive Criticism

There has just reached the General Secretary a report of the annual meeting of the British Columbia branch, which was held at Vancouver last March. After a careful reading of this report, it is quite evident that the Dominion Executive of the Society will have to give particular consideration to the operating policies of the Society and the editorial policy of the official organ, and to make definite changes in both if the interest of members is to be maintained and the interest of new members created.

As part of the programme there was a general discussion of C.S.T.A. affairs. This was led by Mr. W. M. Fleming who had carried out an enquiry among members and non-members in the Okanagan Valley, in order to ascertain just what were the prevailing opinions regarding the Society and the magazine. The replies he received were rather more caustic than otherwise, and served to bring to light many comments which have not often been expressed. The gist of most of the criticism was that the magazine is too technical and that the membership fees are too high for the service rendered.

The sort of survey that Mr. Fleming made, and the opinions which it elicited, are a good thing, particularly if the criticisms are heeded and the recommendations are given real consideration. At the same time the art of criticizing constructively can work both ways and it might do the Society a lot of good if some of its members were told quite plainly that a lot of the blame they place at the door of the C.S.T.A., might well be assumed by themselves. For instance, practically all of the criticisms aimed at the magazine can be answered by stating that its columns are open for the publication of any well-written article and that preference is given to articles by C.S.T.A. members. Up to the present time the vast majority of contributors have been members engaged in research and experimental work. Only one result is to be expected. Many of those who insist that more popular or more readable articles should be featured are members who ought to be writing such articles instead of criticizing the extremely well presented results of research. To say that "approximately ninety per cent of the paper might just as well be thrown into the waste-paper basket" is not criticism—it is pure buncombe.

Criticism of the annual fee is quite as common as criticism of the magazine. As professional men, we who are engaged in agriculture are objecting to the payment of $6.00 per year to maintain a national organization. We complained when the fee was $10. per year and if it is reduced to $5.00 we will still complain. On a $10.00 fee we were on the point of producing profits, which could have been used to undertake and finance new enterprises when our revenue was cut off by reducing it to $6.00. After a financial struggle of four more years we are again producing a surplus, and it will again be removed by a further reduction to $5.00. In the meantime, we cannot reduce our overhead—all we are doing is to shift the burden from the member to the advertiser. Somewhere in the make-up of the professional agriculturist there is a deficiency—as compared with the members of any other professional group, whether they be doctors, lawyers, architects, nurses or engineers. We expect too much for our money and we do not consider that we should make any contribution to a professional and national organization unless we get a direct return or direct benefit from it. The sooner that attitude of mind is changed to a more generous one the better will be the chances for the C.S.T.A. to suceed.

Few members or prospective members realize, or care, what difficulties and obstacles have been overcome by the Society in its development, or the good that it has done to the profession. Nothing would be gained by recounting them. The only thing that needs emphasis, continuously and strongly, is that we need the help and co-operation of every member just as much as we need his criticism.

F. H. G.

La Revue Agronomique Canadienne

RÉDACTEUR—H. M. NAGANT

Le Petit Papillon Blanc du Chou dans la Province de Québec.

LIONEL J. DAVIAULT

Collège Macdonald, P.Q.

Parmi les nombreux ennemis naturels du chou, il ne est un qui mérite surtout notre attention, si nous considérons les nombreux dégats qu''il cause: c'est le Papillon Blanc du Chou (Pieris rapae). Les ravages dûs à ce ptérygote phytophage, en notre province, sont fort importants au point de vue économique, comme le montrent bien les chiffres plus bas mentionnés, nous semblons cependant peu nous en préocuper, peut-être parce que nous sommes habitués à subir ses ravages.

En effet, ce papillon est depuis longtemps établi chez nous. Il parait s''être introduit aux environs de Québec vers 1860, et c'est de Québec qu'il semble s'être propagé dans toutes les autres parties du pays et rapidement puisque dès 1863, on le signale à plusieurs milles autour de la ville de Québec, et en 1865 on le trouvait à Murray Bay, soit 90 milles au nord est de cette ville.

La production du chou est très importante dans le Québec. Il se sème chaque année environ 350 livres de semence de chou d'hiver, et 150 livres de chou d'été et d'automne. La culture se répartit comme suit: Ile de Montréal, 75%, Québec jusqu''en bas, 10%, Sherbrooke et St-Hyacinthe, 5%, Trois-Rivières, Shawinigan et Grand Mère, 5%, Lac St. Jean, 2½%, Région de Hull, 2%. Si nous comptons sur une moyenne de 40,000 plants par livre de semence, nous voyons qu'il se produit environ 20,000 tonnes de choux d'hiver et 9,000 tonnes de choux d'été, d'une valeur d'à peu près $1,000,000.00.

Pour nous convaincre, par des chiffres, de l'énormité des ravages dûs à cette chenille, nous avons entrepris de faire un relevé des pertes subies par quelques cultivateurs des environs de Montréal, dans leurs choux d'hiver. Le nombre de choux détériorés par la chenille variait entre six et huit pour cent. Les chenilles sont donc la cause d'une perte annuelle de 1,400 tonnes de choux d'hiver d'une valeur de $42,000 environ. Notre estimation n'est pas exagérée, car Chittenden, dans son bulletin "The common cabbage worm"', nous dit que les jardiniers américains perdent annuellement une somme de plus de $1,300,000, soit au delà de un dixième de la récolte moyenne annuelle des Etats-Unis.

Cette chenille ne limite pas ses ravages aux choux, elle se nourrit très bien des autres crucifères et le choux-fleur est tout autant dévoré que ce dernier. Le radis est plus rarement attaqué. Au printemps nous avons trouvé des chenilles mangeant sur la moutarde sauvage (Brassica arvensis Lin.) et la bourse a pasteur (Capsella pastoris).

L'insecte fait plus de ravages aux choux d'automne, les choux et les choux-fleurs hâtifs étant expédiés sur le marché avant l'apparition des chenilles en trop grand nombre. L'aspect de la plante attaquée varie beaucoup selon la sévérité de l'attaque, parfois seulement les quelques feuilles de l'extérieur sont dévorées; dans les cas plus graves, tout le parenchyme de la feuille est mangé, si bien qu'au bout de quelque temps il ne reste de la plante que la tige et les nervures principales des feuilles primaires. Les jeunes feuilles étant rongées au fur et à mesure de leur apparition, le coeur

du chou ne peut se former. Le chou n'a alors aucune valeur commerciale.

CYCLE VITAL ET DESCRIPTION DES DIFFERENTS ETATS

Le papillon hiverne sous forme de chrysalide. On peut trouver ces chrysalides un peu partout, dans les trous des murs, les rebords de chassis, les fentes des arbres, etc. Les chrysalides que nous avons observées cet hiver, n'avaient pas cette couleur vert pale caractéristique des chrysalides d'été, mais elles étaient bien développées, de couleur gris-cendré.

Par les premiers beaux jours du printemps, c'est-à-dire vers la fin de mai dans le district de Montréal (28 mai en 1925), les papillons émergent de ces chrysalides et voltigent dans les champs. Quelques jours plus tard, les femelles commencent à pondre donnant naissance à la première génération.

Nous avons capturé plusieurs femelles, le trois juin, pour élever l'insecte en cage. Ces femelles ont pondu une moyenne de 201 oeufs chacune en cinq jours, soit, 37 de pondu le premier jour, 65 le deuxième, 63 le troisième, 24 le quatrième, et 12 le cinquième.

Il est intéressant d'observer la femelle en train de pondre. Elle s'installe bien à l'aise sur la feuille, puis recourbe son abdomen et accole son oviscape fermement contre la paroi épidermique, demeure ainsi quelques instants, et en retirant son abdomen elle y laisse un oeuf. Cet oeuf est de couleur jaune citron et de forme ogivale. On peut remarquer lorsqu'on l'examine à la loupe, 10 à 11 stries longitudinales. Contrairement aux autres piérides, le Pieris rapae ne pond jamais ses oeufs en masse, mais, tout au contraire, il laisse un large espace entre chacun.

La durée de l'incubation est variable, elle peut être de cinq à six jours selon l'époque de l'année. La couleur de l'oeuf se modifie à mesure que la durée de l'incubation augmente. Au temps de l'éclosion, on voit apparaître une déchirure longitudinale. L'ouverture est ensuite agrandie par la larve qui en ronge les parois afin de pouvoir se dégager la tête de cette petite prison. Une fois la tête hors de l'enceinte, le reste du corps passe bien car ce petit monstre la partie antérieure du corps démesurément développée. Cette chenille est toute petite, 1.5mm. tout au plus et de couleur vert pale.

A la première mue les chenilles ne se déplacent que très peu; après la troisième on les trouve partout sur la plante. Elles rongent nuit et jour et se recontrent en aussi grand nombre à le face inférieure de la feuille qu'à la face supérieure. Souvent la jeune larve se dirige vers le coeur du chou, travaille ainsi à l'abri et réapparait à la surface à sa grandeur naturelle, prète à se chrysalider. Elle peut avoir alors un pouce et demi de longueur et la couleur est passée au vert très foncé.

Une fois bien repues et leur dévelopement parachevé, c'est-à-dire, 18 à 28 jours après leur naissance, les larves se dispersent en quête d'un lieu propre à la pupation. La couleur de ces chrysalides est, comme nous l'avons dit plus haut, d'un vert très pale. Cette phase dure de neuf à onze jours dans le Québec.

Les papillons qui en émergent peuvent être décrits comme suit: papillons blancs de grande envergure; L'aile antérieure présente une tache apicale de moyenne grandeur, de couleur gris très foncé, descendant jusqu'au milieu du bord externe. Ailes postérieure, avec une petite tache semblable, au bord antérieur. La femelle est de plus forte taille que le mâle et possède en plus, au bord interne des ailes antérieures, une petite tache allongée et des taches noires rondes dans les intervalles des veines médianes et cubito-anales. En dessous, des ailes postérieures jaunes, saupoudrées de noir.

L'INSECTE EN 1925

Les premiers papillons apparurent en petit nombre le 28 mai. Le trois juin ils étaient en plus grand nombre. Cette première génération se termina aux premiers jours de juillet. Les papillons de la deuxième génération étaient en très grand nombre dans les champs les trois et quatre juillet. Elle se termina entre le deux et le six août. Quelques jours plus tard commençait une troisième génération qui ne put se terminer. Plusieurs chenilles moururent de froid et les autres se chrysalidèrent pour passer l'hiver. Il y a donc trois générations bien définies de cet insecte dans la province de Québec.

ENNEMIS NATURELS

L'orde des hyménoptères offre plusieurs espèces qui font la guerre à la chenille du chou. Les deux plus importants sont l'Apanteles glomeratus, Linné, et le Pteromalus paparum, Linné. Ces deux parasites sont

importés d'Europe, le premier fut introduit vers 1870-71, le deuxième vers 1880.

La femelle de l'Apanteles aggloméré pond ses oeufs dans le corps des chenilles; chaque chenille est ainsi la proie d''un certain nombre de petites larves qui tissent, autour de son corps, de minces cocons de soie jaune où elles se chrysalident. Le Pteromalus puparum dépose ses oeufs aussi dans le corps de la chenille et toutes ses métamorphoses se passent sur la chenille, se continuant au sein de la chenille mourante.

Nous avons trouvé dans une de nos cage, une mouche tachinide (pas identifiée) parasite de la chenille du chou.

Une maladie très répandue chez les chenilles, est la Flacherie; chaque année quantité de chenilles sont détruites de cette façon. Elle fut particulièrement commune cette année et il nous a été difficile parfois d'en préserver les chenilles, dans nos cages d'observation. Chez les chenilles atteintes de la maladie, on observe des changements de couleur; tout le corps devient brun, puis passe au noir. On remarque aussi un recoquevillement des tissus. Au début de la maladie, les chenilles ne sont aucunement changées dans leur apparence externe, si ce n''est qu'elles manquent d'appétit et deviennent molles; la mort peut suivre l'apparition de ces premiers symptômes.

REMEDES

En face des terribles ravages causés par cet hexapode dans nos jardins, il faut songer aux moyens dont nous pouvons disposer pour y remédier. On trouve ces remèdes dans les arsénicaux.

L''été dernier différents produits, sous des formes différentes, furent experimentés chez des cultivateurs de Ste. Dorothée et St. Michel. Autant que faire se pouvait, des champs de mêmes dimensions, et au même degré d'infestation étaient choisis afin de faciliter le travail de comparaison des résultats.

Dans le tableau suivant nous avons résumé toutes nos observations.

Matériel employé	*Resultat*
arséniate de chaux 1-10	Les choux se développèrent très bien mais les feuilles de l'extérieur demeurèrent fortement endommagées.
arséniate de chaux 1-15	Résultats identiques.
arséniate de plomb	Excellent contrôle, à peu près toutes les chenilles mortes le deuxième jour.
arséniate de chaux 2 livres, 50 gallons d'eau, 10 livres de chaux, ½ de mordant.	Assez bon résultat, mais plusieurs cas de brûlure. Le matériel adhère bien.
arséniate de chaux, 3 livres etc.	Chenilles presque toutes mortes, mais beaucoup de brûlure

Ces résultats nous montrent la supériorité des poudres sur les arrosages. Cela s'explique assez facilement. Les liquides adhèrent difficilement sur la feuille du chou qui est recouverte d''une mince couche de cire. Il faut employer du savon ou des mordants trouvés dans le commerce pour augmenter le pouvoir d'adhésion des liquides. Il est plus difficile de faire un bon arrosage et cela prend aussi plus de temps.

L''arséniate de plomb s'est montré un peu supérieur à l'arséniate de chaux, et aucun cas de brûlure ne fut observé quand il fut employé.

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ACTIVITES DES SECTIONS

Section de Ste. Anne de la Pocatière

Réunion du 2 mai 1926

Le conferencier du jour fut, le Révérend H. Bois, Professeur à l''Ecole d''Agriculture de Ste-Anne de la Pocatière, qui eut dernièrement le privilège d'ètre envoyé par le Département d'Agriculture recueillir des renseignements sur les possibilités d'ouvrir un marché sur l'Ile de Cuba. Pendant ce voyage, il a pu recueillir de précieuses informations sur les nouveaux débouchés, tout en visitant les principaux centres de la Floride.

Le conférencier fait remarquer que l'Ile de Cuba achète au-delà de 5 millions de minots de pommes de terre qu''elle paye ordinairement très cher, et demande un produit de toute premiére classe; en plus, exige que les expéditions soient acompagnées de certificats émis par les Officiers de la Division de la Botanique, certifiant qu'elles sont exemptes de maladies sérieuses. Comme le pouvoir d''achat de l''Ile de Cuba est très grand, il serait très profitable pour nous de faire du commerce avec ce pays. Pour arriver à ce but, le Rev. H. Bois suggère la formation d'une bonne organisation. Le conférencier nous fit ensuite l'historique de la Floride, et s'étend longuement sur le cachet champêtre de ce beau pays dont la température moyenne en hiver, à Miami, est de 68°F. et en été de 81°F.

Le Révérend H. Bois traite aussi de l'avenir de la Floride, et nous dit que c'est un pays de soleil, un pays qui produit quand le reste de l' Amérique dort. L'avenir de la Floride offre les plus belles perspectives; avec l'excellente terre que possède cette région, elle ne peut que se développer. Cependant le conférencier conclut: A tout prendre, notre pays a autant d'avantages, "L''avenir est à ceux qui luttent", ici, nous avons à lutter contre la terre, le climat, etc.

Il termine son intéressante causerie en disant quelques mots de la colonie canadienne de Ste-Anne des Laos, et fait remarquer que nous y comptons plusieurs bons amis qui sont actuellement propriétaires de terrains dans cette région.

M. Charbonneau, président de la section, qui avait présenté le conférencier, demanda à M. Ls. de G. Fortin, Professeur, de remercier le Rev. H. Bois, ce qu'il fit avec beaucoup d'àpropos.

On remarquait à la table d'honneur: Messieurs R. P. Charbonneau, Président, Assistant-Régisseur à la Station Expérimentale d Ste-Anne; Rev. H. Bois, Professeur à l'Ecol d''Agriculture de Ste-Anne; D. Fortin, Vice Président, Agronome Officiel de l'Ile Verte Ls. de G. Fortin, Professeur à l'Ecole d'Agriculture; H. N. Racicot, Pathologiste, Laboratoire de Pathologie Végétale.

Etaient en outre présents: Messieurs Phaneuf, Agronome de Rimouski, L'Abbe Giasson Charles Gagné, Pierre St-Hilaire, George Gilbert, F. X. Gosselin, Joseph Michaud Léopold Raynauld, Harry Tremblay, Albert Sirois, Elzéar Campagna, Dr. G. J. A. Dupré B. Baribeau.

B.B.

Section de Montréal

Le dernier diner-causerie de l'année académique a eu lieu, au cercle universitaire, l samedi ler Mai. Au dessert les convives eurent de nouveau l'avantage d''entendre u technicien agricole du Département fédéra de l'agriculture, en la personne de monsieu Albert Gosselin, agriculteur adjoint à l Ferme Expérimentale d'Ottawa, qui développa le sujet suivant: "Importance des recherches économiques sur le développment d l'Agriculture".

Monsieur Gosselin insista surtout sur l'importance d'une parfaite coordination des efforts de tous ecux qui travaillent au développement de l'Agriculture. Il fit ressortir l nécessité de classifier les diverses région d''une province, d'après les genres d''exploitation agricole auxquels elles se prêtent l mieux. Après cette question de production qui constitue le facteur fondamental d'un programme agricole, il traita du problème transport et marchés qui représente un autre facteur important.

En terminant le conférencier préconis l'établissement d'un service d'économie rural qui coordonnerait les travaux de chacune de divisions d'un département d'agriculture Actuellement, dit monsieur Gosselin, les divisions développent principalement le côt

echnique des problèmes qui les concernent t ne s'occupent qu'incidemment de la question économique.

Présenté par monsieur H. M. Nagant, le onférencier fut vivement remercié par monieur J. N. Ponton qui profita aussi de l'ocasion pour rendre un hommage bien senti, ses qualités personnelles. Ensuite il fut rocédé à l'élection de l'exécutif de la sesion pour l'année qui commence. L'ancien ureau, composé de messieurs H. M. Nagant, résident, R. A. Rousseau, vice-président et
. Toupin secrétaire-trésorier fut confirmé ans ses fonctions pour un nouveau terme.

Outre les membres présents de la section e Montréal, nous eumes le plaisir de voir notre table messieurs Fred H. Grindley, ecrétaire général de la C.S.T.A., J. Ch. Magnan et Roger Charbonneau, présidents espectivement des sections de Québec et de Ste-Anne de la Pocatière.

OFFICIER D'ACADEMIE

M. Alphonse Désilets, B.S.A., Chef du Serice de L'Industrie Domestique, au Ministère e l''Agriculture de Québec, vient d'être ommé par le Gouvernement Français, "OFFICIER D''ACADEMIE" et l'agent consulire de France, M. H.-R. de St-Victor, a remis M. Désilets le diplôme et les insignes de a décoration le 5 mai dernier.

Tous les membres de la C.S.T.A. seront eureux d'adresser leurs félicitations au ouveau décoré dont l'oeuvre littéraire s''inpire d'un patriotisme aussi profond que son mour du sol.

Au moment de mettre sous presse, nous pprenons qu'un nouvel honneur vient 'échoir à monsieur Désilets qui a aussi été écoré du "Mérite Agricole" de Belgique.

NOUVELLES DE NOS ECOLES D'AGRICULTURE

Institut Agricole d'Oka

Monsieur Albert Leduc, Assistant profeseur de chimie à l'Institut Agricole d'Oka, ient d'obtenir son diplôme de "Master of cience" de l'Université McGill, de Montéal.

Pour l'obtention de ce titre, monsieur Leduc avait présenté une thèse intitulée: "Turbidity tests on butter fat and its substitutes"' Monsieur Leduc mérite nos sincères félicitations pour avoir mené à bien ce travail long et délicat qui lui fut imposé.

Quatre élèves finissants ont obtenu leur titre de "Bachelier en Sciences Agricoles". Ce sont Messieurs: Henri L. Bérard, Paul Omer Roy, J. M. Alvarez St-Denis et Raoul J. L'Ecuyer. La collation solennelle des diplômes a eu lieu à l'Université de Montréal, le vendredi 28 mai. A nos très cordiales félicitations, nous joignons nos voeux de bon succès à ces nonveaux confrères qui vont débuter dans la carrière agronomique.

Par les divers journeaux quotidiens, et autres, on aura déjà appris que la fondation de l'association des Anciens Elèves de l'Institut Agricole d'Oka est chose faite, et que la date du premier conventum, à été fixée aux 12 et 13 du mois de juin prochain. Ce sera certainement aussi avec intérêt qu'on apprendra que le premier numéro de l'organe officiel de la nouvelle association, "La Revue de l'Institut Agricole d'Oka" qui est appelée à paraitre tous les deux mois, vient de sortir. Nous n'en dirons pas plus car il est bien probable qu'au moment où paraitront ces lignes, tous les Anciens d'Oka auront déjà la nouvelle publication issue de leur Alma Mater, entre les mains. Contentons-nous de lui souhaiter longue vie et une action féconde pour les intérêts agricoles de notre Province.

Etat actuel de la question de l'acidité du sol

On sait que le problème de l'acidité du sol se révèle de plus en plus complexe à mesure qu'on l'étudie davantage. Ceci est encore une fois mis en évidence dans une étude parue sous la signature de L. Frésénius dans "Zeitschrift fur Pflanzenernahrung und Düngung" Tome 4, No. 5, p. 200-212, mai 1925.

Nous empruntons à la Revue "Chimie et Industrie", numéro de janvier 1926, le résumé suivant de cette étude:

La question de la détermination de l'acidité du sol a pris, en Allemagne, pendant ces dernières années, une importance capitale. On s'est rendu compte que la plupart des sols minéraux présentaient une réaction nettement acide, et qu'il importait de combattre, avec des armes convenables, le préjudice ainsi porté à la végétation.

Les recherches effectuées en vue de déterminer l'acidité ont jusqu'ici fourni des résultats souvent contradictoires. Ces divergences tiennent surtout au fait qu'il n'existe pas de définition précise de l'acidité de sol. Kappen a fait remarquer que les savants ont attribué à l'acidité du sol quatre interprétations différentes.

Les uns mesurent l'acidité par le nombre d'ions H présents dans une solution aqueuse du sol. Mais on sait actuellement que la nature acide d'une solution est caractérisée, non seulement, par sa concentration en ions H, mais encore par son acidité de "titrage" et son acidité d "opposition."

Le nombre d'ions H est déterminé par des mesures électrométriques ou colorimétriques. L'acidité de "titrage" indique le nombre d'équivalents acides dans la solution. Ces deux acidités sont ordinairement très différentes, par suite de la présence, dans le sol, de composés tels que le chlorure d'aluminium, qui possèdent la propriété de se scinder partiellement, en solution aqueuse, en alumine et acide chlorhydrique. $Al^2 O^3$ étant une base faible et HCL un acide fort, la solution aura une réaction nettement acide, que l'on pourra mesurer par électrométrie. Mais si l'on titre la solution par de la soude diluée, jusqu'à neutralisation, on trouvera, par suite de la présence de l'alumine, une valeur beaucoup plus élevée que dans la détermination précédente. Ce phénomène est attribuable à la décomposition progressive du chlorure d'aluminium, au fur et à mesure de la neutralisation par NaOH de l'acide chlorhydrique libéré.

Par acidité d'"opposition", on comprend généralement la propriété qu'ont certaines substances de s'opposer aux changements de concentration en ions H, et de protéger par suite le sol contre les variations rapides d'acidité, soit lors des additions d'engrais, soit au cours d'applications de chaux. Enfin, la décomposition des roches silicoalumineuses (feldspaths) fournit des silicates basiques colloïdaux facilement décomposables par les acides. Ces silicates basiques (zéolithes) ont une grande importance dans les champs où leur présence s'oppose à l'action fertilisante des engrais. La question des changements subis dans le sol par les zéolithes n'a pas été élucidée jusqu'ici. On peut croire soit à des phénomènes d'absorption, soit à des modifications de composition, sous l'influence des acides (CO^2) ou des engrais physiologiquement acides. Les constituants des zéolithes ont la propriété de décomposer les sels facilement hydrolysés en s'unissant aux bases et libérant les acides. Ils ont donc pour effet d'engendrer dans le sol une acidité dite" hydrolytique", qu'il n'est pas possible de mettre en évidence par les méthodes usuelles, et qui est très redoutable, car elle s'oppose au développement des micro-organismes nitrifiants. Kappen a montré qu'une acidité hydrolytique de 10 cm^3 environ suffisait pour s'opposer à la croissance de la luzerne. Cette acidité se détermine par agitation de la terre avec une solution d'un sel facilement hydrolysable, tel que l'acétate de soude. Il a été établi que la limite supérieure de cette acidité atteignait environ 4 à 5 cm^3 de soude N/10.

L'auteur termine son étude par un résumé des méthodes proposées pour la détermination des différentes formes d'acidité du sol: méthodes Arrhenius, von Hudig, Christensen, Comber, etc.

De tout cela nous pouvons conclure que les méthodes employées pour déterminer, à quelques centaines de livres près, la dose de chaux nécaissaire pour l'amendement d'un acre de sol, d'arès l'estimation quantitave de l'acidité sont bien précaires au point de vue pratique.

Some Experiments in Mineral Feeding.

R. D. SINCLAIR and J. P. SACKVILLE

Department of Animal Husbandry, University of Alberta, Edmonton,

Recent studies and experiments in the field of animal nutrition have brought into the spotlight the importance of a sufficient supply and a proper balance of the various mineral elements in order that all body activities may proceed normally.

"Minerals are not now considered as a medicine to be fed in doses, but as a food to be supplied daily". This statement made not long ago by one authority indicates fairly definitely the present attitude towards the use of minerals in livestock feeding. Data so far obtained have shown at least one fact—that while the mineral requirements of farm animals is relatively small there are certain conditions when even this limited demand will not be met and the supplementing of ordinary rations with simple mineral mixtures will be reflected in more rapid growth and increased milk production, as well as a more efficient utilization of the feed consumed.

Without going into detail with respect to the part the various mineral elements play in the animal's body, some of the more important functions they perform might be mentioned: (1) for constructive purposes, (2) as carriers of gaseous and liquid products, (3) to maintain the body fluids at their normal reaction, neutral, acid or alkali as the case may be, (4) muscular and nervous control, (5) to assist in the coagulation of the blood, (6) for bringing certain food constituents into solution and for the digestion of practically all food nutrients. The role of minerals in the animal body is so varied and vital and their relationship with each other so important that the proper amount and proportion in the daily ration is one of considerable concern.

The supplementing of rations with mineral mixtures is associated with at least some degree of uncertainty when they are not self-fed; there is always the danger of upsetting the balance of the various elements. The interdependence of calcium and phosphorous for example is such that a ration deficient in calcium may result in phosphorous starvation; in the same way phosphorous is necessary for calcium storage. On the other hand some minerals may retard the storage of others—for example, too much magnesium may prevent calcium storage. In the light of this knowledge and until further information is available the practice of adding minerals to the ration should be done with an appreciation of what it involves.

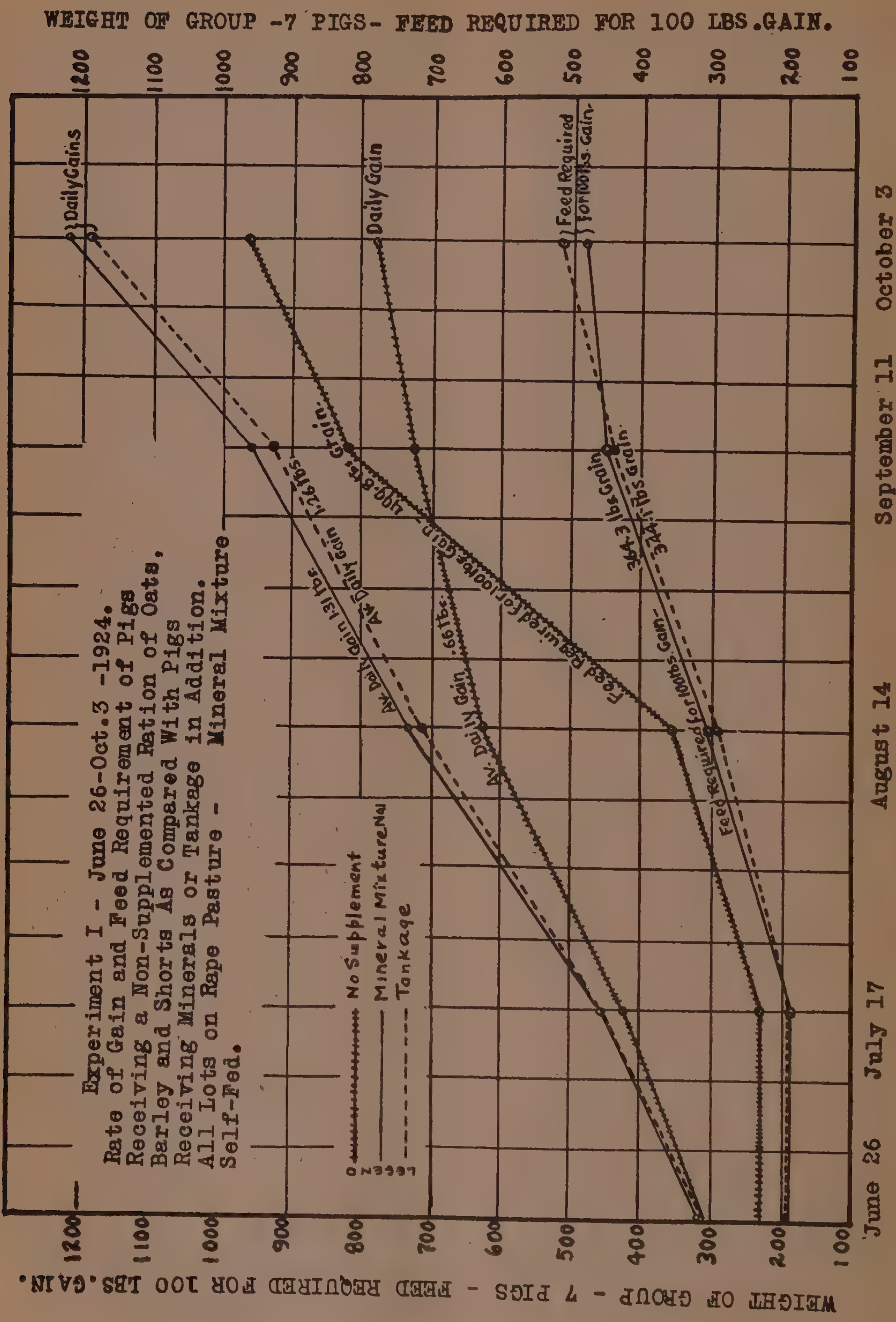
A deficiency of the necessary mineral elements is most likely to occur in the case of dairy cattle and swine, the former on account of the extreme demand made in the production of milk and the latter due to the rapid increase in body weight, together with the fact that comparatively little of the calcium-bearing feeds such as the roughages are consumed by hogs. Considerable experimental work has been conducted within the past three years in the feeding of simple mineral mixtures to both dairy cattle and swine. With the object of presenting the results of two years' work conducted at the University of Alberta with the feeding of minerals to hogs on pasture, this report is submitted at this time.

Experiment I

The first experiment in feeding minerals to pigs on pasture at the University of Alberta was carried on during the summer of 1924. This trial was conducted mainly with the objects of determining the value of adding a simple mineral mixture to the ration of pigs being fed on oats, barley and shorts ration, of comparing simple and complex mineral mixtures and of finding out whether pigs being fed a tankage allowance would respond to the use of a mineral mixture. The simple mineral mixture (No. 1) used in this experiment consisted of:

Slack coal	185	pounds
Air slacked lime	5	"
Salt	8	"
Sulphur	2	"

It was thought that this mixture containing the "palatable" slacked coal as a base would


WEIGHT OF GROUP -7 PIGS- FEED REQUIRED FOR 100 LBS.GAIN.
1200 1100 1000 900 800 700 600 500 400 300 200 100
Experiment I - June 26-Oct.3 -1924.
Rate of Gain and Feed Required of Pigs
Receiving a Non-Supplemented Ration of Oats,
Barley and Shorts As Compared With Pigs
Receiving Minerals or Tankage in Addition.
All Lots on Rape Pasture - Mineral Mixture
Self-Fed.
LEGEND
No Supplement
Mineral Mixture Nal
Tankage
Daily Gains
Daily Gain
Feed Required for 100 lbs. Gain.
1.26 lbs.
Av. Daily Gain 1.31 lbs.
Av. Daily Gain
Av. Daily Gain .66 lbs.
400.6 lbs. Grain.
Feed Required for 100 lbs. Gain
364.3 lbs Grain
324.1 lbs Grain.
Feed Required for 100 lbs. Gain
June 26
July 17
August 14
September 11
October 3
WEIGHT OF GROUP - 7 PIGS - FEED REQUIRED FOR 100 LBS.GAIN.

ntain some of the more important elements cely to be lacking in our ordinary rations. ne complex mixture (No. 2) used was of wa State Experiment Station origin and nsisted of:

Salt	14	pounds
Air slacked lime	28	"
Raw bone meal	28	"
Potassium Chloride	5	"
Flowers of Sulphur	10	"
Glaubers Salt	10	"
Epsom Salts	1	"
Copperas	1	"
Potassium Iodide	.035	"
Manganese Sulphate	1	"
Sodium Silicate	1	"
Potassium Aluminum Sulphate	1	"

These mineral mixtures were placed before e pigs in self feeders rather than being fed ith the grain ration in any definite quantity. ll lots were pastured on rape. Buttermilk as fed in all lots at the rate of 6 pounds er head daily at the start of the test, gradally reducing the amount until they were ot receiving any at the end of 28 days. Tankge was fed to the two groups receiving this ipplement at the rate of 5 per cent of the rain allowance.

Some of the more important details of the esults of this experiment are shown in able I. The most striking feature to be oted in this table is the manner in which ne pigs responded to the use of the simple ineral mixture No. 1.

A comparison of Lots I and II shows that gains were doubled and the grain requirement reduced by 27% through allowing pigs access to the coal, lime, salt and sulphur mixture. The second mineral mixture (Lot III) did not promote as rapid gains as the simple mixture, but the results in both gains and economy of gains indicate that this mixture supplied some of the deficiencies in the ration of Lot I. The fact that gains were not as high in Lot III as in Lot II suggests that while a greater variety of elements was provided in the complex mixture, the normal mineral balance may not have been maintained and metabolism thereby disturbed. The grain requirement however, was lower in Lot III than in Lot II. It is to be noted in this experiment that the addition of the simple mineral mixture to the ration of the pigs receiving tankage did not improve conditions. The 5% allowance of tankage apparently made provision for the necessary mineral content of the ration.

Experiment II.

In connection with the second experiment conducted during the summer of 1925 three mineral mixtures were used. The No. 1 mixture used in the first experiment was revised to:

Slacked coal	76.5	pounds
Air slacked lime	2.5	"
Salt	20.	"
Sulphur	1	"

The proportion of slacked coal was reduced and the proportion of salt increased on the assumption that the first mixture con-

Table No. I. Results of Experiment I—Feeding Mineral to Swine on Pasture. University of Alberta, June 26 to October 3, 1924.

	LOT I. Grain alone	LOT II. Mineral Mixture No. 1	LOT III. Mineral Mixture No. 2	LOT IV. Tankage	LOT V Tankage and Mineral Mixture No. 1
No. of pigs in group	7	7	7	7	7
Ave. Initial weight	45.5	46.0	45.3	45.8	45.8
Av. final weight	116.0	181.7	166.2	177.0	173.1
Av. daily gain	.66	1.31	1.10	1.26	1.21
Feed required for 100 lbs. gain:					
Grain	499.8	364.3	341.09	344.1	343.7
Buttermilk	207.2	107.5	126.5	111.2	114.7
Tankage	——	——	——	18.1	18.1
Minerals	——	48.2	3.59	——	30.9

Experiment II.—Lot 1—Oats, Barley and Shorts—Rape Pasture.
Average Daily Gain—June 26 to Oct. 7, 1925—.70 lbs.

tained too much coal in relation to other ingredients and that the good results secured from the use of this mixture were in a large measure due to its salt content. The No. 2 mixture was also revised to some extent and in this experiment was constituted as follows:

Salt	15	pounds
Raw bone meal	65.65	"
Potassium Chloride	5.	"
Flowers of Sulphur	4.	"
Glaubers salt	5.	"
Epsom salts	1.	"
Copperas	1.	"
Potassium Iodide	.35	"
Manganese Sulphate	1.	"
Sodium Sulphate	1.	"
Sodium Silicate	1.	"

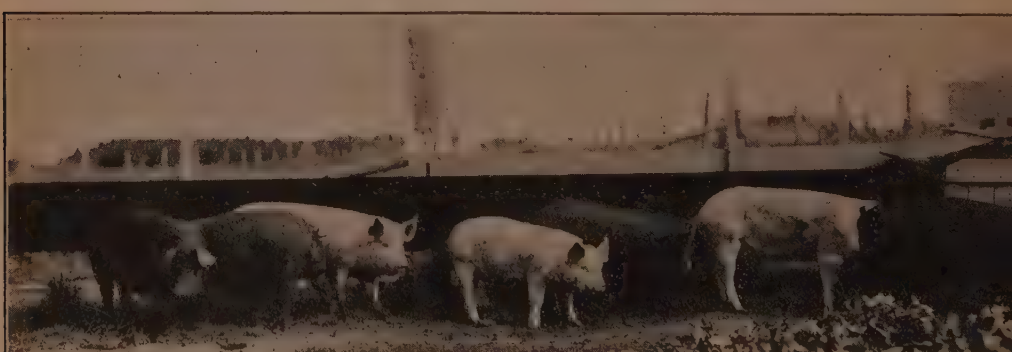
A third mixture was included in this test. It consisted of:

Slacked coal	98	pounds
Bone meal	60	"
Salt	40	"
Sulphur	2	"
Potassium Iodide	1	oun

This mixture is similar to the simple ture (No. 1) in so far as the main con uents are concerned, the main difference ing the substituting of bone meal for slacked lime and the addition of .003% potassium iodide.

In addition to the feeding of the three eral mixtures outlined above a group of self-fed salt alone, in addition to the g ration, was included in this experiment.

The results of the second experiment shown in tabular form below. In inter ing these results it is well to keep in that such conditions as grain rations, me of feeding, pasture, etc., were identical those in Experiment I.



Experiment II.—Lot II.—Oats, Barley and Shorts—Rape Pasture and Mineral Mixture No. 1
Average Daily Gain—June 26 to Oct. 7, 1925—1.34 lbs.

Table II. Results of Experiment II—Feeding Minerals to Swine on Pasture. University of Alberta. June 26th to October 7th, 1925.

	LOT I. Grain alone	LOT II. Mixture Mineral No. 1	LOT III. Mineral Mixture No. 2	LOT IV. Mineral Mixture No. 3	LOT V. Salt	LOT VI. Tankage	LOT VII. Tankage Mineral Mixture No. 1
No. of pigs in group	8	8	8	8	8	8	8
Av. Initial weight	49.2	51.2	52.2	55.6	50.5	51.8	53.8
Av. Final weight	117.9	182.5	173.0	186.0	173.1	172.2	186.2
Av. daily gain	.70	1.34	1.23	1.33	1.24	1.23	1.34
Feed required for 100 lbs. gain:							
Grain	651.1	406.62	460.0	400.7	440.2	394.2	401.7
Buttermilk	175.8	91.9	92.2	92.5	99.4	100.2	91.8
Tankage	——	——	——	——	——	20.8	21.14
Minerals	——	30.3	5.30	23.03	5.21	——	9.43

The results of this experiment agree very closely with those obtained in the first trial. The use of the revised simple mixture No. 1 increased the average daily gains by 90 per cent. and decreased the grain requirement by 30 per cent. (Lots I and II). The reduction in the amount of coal in this mixture is reflected in the lower mineral requirement in Lot II as compared with the previous year. The lower feed requirement in Lot II as compared with the previous experiment seems to indicate a more desirable relationship between the slacked lime and salt in this mixture.

The complex mixture No. 2 failed to give as good results as the simple mixture. The fact that daily gains are lower and feed requirement higher in the case of this group (Lot III) suggests that some of the minerals provided in this mixture were not only superfluous under the conditions of this experiment but may have disturbed normal digestion and metabolism.

The No. 3 mixture containing bone meal and potassium iodide was highly efficient in promoting gains and cutting down the feed requirement for 100 pounds of gain. The rate of gain was practically the same as in Lot II and the feed requirement slightly lower. The good results secured from this mixture may be, in part at least, due to its potassium iodide content.

The results secured from salt feeding in this experiment (Lot V) are interesting. It would appear that the unsatisfactory results

Experiment II.—Lot V.—Oats, Barley and Shorts—Rape Pasture and Salt (Salt-Fed). Average Daily Gain—June 26 to Oct. 7, 1925—1.24 lbs.

secured from the non-supplemented ration (Lot I) is due in a large measure to salt starvation. It is reasonable to suppose that the good results secured from the simple mineral mixtures centre around the sodium chloride content of these mixtures. That the other ingredients used were of value however, is made clear by the higher gains and lower feed requirement when slacked coal, slacked lime, bone meal and sulphur were fed in addition.

While in the first experiment the addition of a simple mineral mixture to the ration of pigs receiving tankage gave a negative result, in the second instance a slight increase in gains and a slightly lower feed requirement were secured. In view of the result in the first experiment and the narrow margin of improvement in this case (Lots VI and VII) it is doubtful if this result can be regarded as significant. It would seem that with pigs on rape pasture a 5 per cent. tankage allowance will provide the necessary mineral matter.

A feature worth noting in connection with this study is that in both experiments the self-feeding of simple mineral mixtures has given rise to higher daily gains in every case and in some cases a lower grain requirement than when a 5 per cent. allowance of tankage was fed with the grain ration. In all cases, due to the low cost of the mineral mixtures as compared with tankage, gains were more economical. Under the conditions of these experiments, with pigs placed on pasture at an initial weight of between 45 and 50 pounds and with buttermilk fed for the first 28 days, the main factor limiting growth on the grain ration used would seem to be mineral matter rather than protein. This conjecture is especially worthy of note in view of the prevalent opinion that the greatest need in swine feeding in Western Canada is in connection with protein supplements.

A Statistical Study of the Gains

Before concluding the discussion on these experiments brief reference to a statistical study made of the gains in some of the groups in the second experiment may not be out of place. The mean daily gain together with the probable error and the co-efficient of variability of the groups is shown in table III.

Table III. Statistical Study—Experiment II

	Mean Daily Gain and Probable Error.	Co-Efficien of Variability
Lot I—Grain alone	.667±.073	46.21
Lot II—Minerals No. I	1.354±.043	13.35
Lot III—Minerals No. II	1.243±.032	10.78
Lot IV—Minerals No. III	1.349±.056	17.53
Lot V—Salt	1.265±.048	15.97
Lot VI—Tankage	1.240±.036	12.09
Lot VII—Tankage and Minerals No. 1	1.339±.022	6.99

The very high probable error in Lot I in dicates that in addition to the low gain made on the non-supplemented ration, ther was a very unsatisfactory reaction amon the pigs within this group. Pigs of th initial weight used in this experiment, eve though on good rape pasture, evidently su fered from mineral or protein deficiency o both. The probable error is considerabl smaller and the co-efficient of variability i much less in the groups where mineral ma ter is supplied.

Comparing the results secured from th use of the various mineral mixtures it is in teresting to note that the variation in gair is smallest in the case of the group fed th complex mixture even though the mean dai gain is lower and, as was noted previousl the feed requirement higher. It may be tha with pigs within the group ranging in initia weight from 40 to 65 pounds, the comple mixture provided a more desirable variet of minerals for the lighter weight pigs.

HUNTING FOR MINERALS
Fall Pigs on a Non-Supplemented Experimen Ration during the winter of 1925-26 showed decided craving for mineral matter. Univers of Alberta. Photo Feb. 23, 1926.

A comparison of Lots IV and V shows that the group receiving coal, lime, and sulphur in addition to salt reacted more favorably to the mixture from the standpoint of individual gains than the pigs receiving salt alone. This is in line with the lower feed requirement in Lot II. The mean difference in daily gains between Lot II (minerals No. 1) and Lot V (Salt) together with its probable error was .089±.065. This mean difference is 1.38 times its probable error. This would lead to the expectation that future experiments similarly planned and conducted would result in 83% of the cases showing better results from the feeding of the simple mixture than from the use of salt alone.

It has been mentioned already that the addition of a simple mineral mixture to the ration of pigs receiving a 5 per cent. tankage allowance seems of doubtful value. Table III shows that the co-efficients of variability in Lots II (minerals No. 1) Lot VI (Tankage) and Lot VII (Tankage and Minerals) were: 13.35, 12.09, and 6.99 per cent respectively.

The combination of tankage and minerals gave rise to very uniform gains within the group. The mean difference between daily gains in Lots VI and VII together with its probable error was .099 ± .042. The mean difference is therefore 2.35 times its probable error. From this we would expect that further experiments of this nature would yield results similar to those secured with groups VI and VII in 95 per cent of the cases.

Conclusions

The experiments reviewed have only been conducted during two seasons and the writers regard them only as paving the way for more detailed work in mineral experimentation. These trials open up such questions as the relative values of the various constituents of the simple mineral mixtures used and the relative importance of mineral and protein deficiencies in the grain rations and pasture crops available. The future program involves considerable analytic work with the various grains fed and pasture crops utilized, especially with respect to mineral content, so that the mineral mixtures used may be revised on a sound basis. The results secured thus far are of interest and seem to lead to the following conclusions:

1. The use of a simple mineral mixture when dairy by-products or tankage are not fed in addition to the ordinary grain ration, will result in considerable increased gains and a lower feed requirement.
2. Under these conditions the use of salt alone will prove of material benefit. No difficulty was encountered in these experiments from salt poisoning and the results indicate that many pigs in Western Canada suffer from salt starvation. Of the various ingredients in the mineral mixture used sodium chloride was no doubt the most provocative of good results.
3. It would appear that with pigs of such initial weights as used in these experiments, and under similar conditions as to grain rations and pasture, the question of mineral deficiency is of greater consequence than that of protein deficiency.

Plant Physiology in Relation to Agronomy.*

T. J. HARRISON

Manitoba Agricultural College, Winnipeg.

The trend of thought among agronomic research workers is that the agronomist of the future must apply to a greater extent the fundamental sciences in the solution of field crop problems. The writer's experience for fifteen years in Western Canada, in both experimental station and college work, demonstrates that in this area the day of the pioneer experimentalist is also past, and that the successful field crops experimenter of the future must rely upon the underlying sciences to explain the phenomena of his field results.

Among the fundamental sciences, plant physiology is probably the one that has the closest relation to agronomy. It has been defined as "the science of plant functioning" or the application of plant physics and phytochemistry tothe processes of seed germination, plant growth, seed production, and plant decay. Agronomy is the science of crop production as measured ordinarily in yield and quality of crop. It has to do with the effect of heredity and environment on crop plants. At most institutions it includes hereditary studies in soil and crop experimentation. It is with the relation of plant physiology to field crop experimentation that this paper will deal in particular.

History of Agronomy and Plant Physiology

The history of field crop experimentation indicates that at various times the experimenters have endeavored to apply the knowledge of plant physiology to explain their results. Previous to 1600 A.D. there was little or no experimental work and the explanation of natural phenomena was based on speculation.

Van Helmont, about 1640, performed the first really scientific experiment, but because he did not understand the principles of plant physiology, his theory explaining the fact was incorrect. He explains his experiment as follows:—

"I took an earthen vessel in which I put 200 pounds of soil dried in an oven, then I moistened with rain water and pressed hard into a shoot of willow weighing 5 pounds. After exactly five years the tree that had grown up weighed 169 pounds and about 3 ounces. But the vessel had never received anything but rain water, or distilled water to moisten the soil when this was necessary, and it remained full of soil which was still tightly packed, and lest any dust from outside should get into the soil, it was covered with a sheet of iron coated with tin, but perforated with many holes. I did not take the weight of the leaves that fell in the autumn. In the end I dried the soil once more, and got the same 200 pounds that I started with, less about two ounces. Therefore the 164 pounds of wood, bark, and root, arose from the water alone."

In the seventeenth century, Jethro Tull, by field experimentation, found that cultivation before seeding and inter-tilling, increased crop yields. He endeavored to explain his results as some of the experimenters of the present time, by theorizing without a knowledge of the underlying principles. According to his view, it was not the "juices of the earth", but "the minute soil particles that constituted the proper pabulum of plants." The growing roots forced the minute particles into the "lacteal mouths of the roots". All plants lived on these particles. Any plant would grow on any soil, provided it was well cultivated. Therefore, rotations were not beneficial in themselves.

In the latter part of the eighteenth century great interest was taken in agriculture, and many experiments were conducted and facts accumulated. Because of the inadequacy of plant physiological knowledge, no attempt was made to explain the facts. For example, Arthur Young and Lord Townsend (Turnip Townsend) knew that wheat and barley gave better results after turnips and clover, but did not attempt to explain the reason. This was probably due to the fact that during this period several theories were being advanced by plant physiologists and chemists, and controversy was rife. About 1800, Priestly Ingen-Housz, and Senebier made their classical discoveries on the carbon assimilation of

*Paper read before the Western Canadian Society of Agronomy, Saskatoon, Sask., December, 1925.

the plant. In the nineteenth century the Rothamsted Experiment Station was established. Lawes and Gilbert first determined the crop response to certain fertilizers. They then began their work on the mineral nutrition of plants. Here the agronomist endeavored to assist the plant physiologist in the underlying principles. Their work on mineral nutrition is on a parity with Ingen-Housz, and contemporaries on carbon assimilation.

The application of nitrate nitrogen was found to improve some crops, and not others. The source of the plant nitrogen was a much debated point between Liebig, Lawes and Gilbert, and others, until Hellriegal and Wilfarth made their discovery that non-leguminous plants responded to nitrogenous fertilizer more readily than others. Beijerinck later discovered the organism. This cleared up the discrepancy between the laboratory and field trials of Rothamsted. During the latter part of the nineteenth century the plant physiologist again overtook the agronomist and ever since has had a fund of information that would be valuable to the crop experimenter.

In the United States and Canada, the field crop experimenter has always considered the field as his laboratory, and has been particularly interested in determining the most profitable cultural practices as measured in yield per acre, without regard to the underlying causes. The reason for this is probably the fact that institutions where this work has been carried on, were financed from public funds and the legislatures insisted that only "practical" problems should be investigated. In the pioneer days, this type of investigation did establish profitable practices. Dr. Angus McKay of Indian Head, Saskatchewan, developed the system of summer-fallowing, for the Great Plains area of Canada. Dr. S. A. Bedford, of Brandon, Manitoba, established the fact that Brome Grass (*Bromus inermis*) would control soil drifting in the light dry soils of Western Canada. But, when the experimenter tried to determine the best method of bare fallowing, or the best method of growing grasses, the field method of measuring the results sometimes has led to erroneous conclusions.

Fundamental Sciencies and the Industrial

During the last decade, and particularly since the Great War, manufacturers have been employing scientifically trained men to work on their problems, i.e., applying science to explain the phenomena, and with this knowledge, improving conditions. This is well illustrated by the chemist in the flour mill industry, in the malting industry, in the oil and paint industry, and in the sugar beet industry. There is not a progressive industrial institution that has not its laboratory and staff of trained workers.

In most technical research laboratories the application of the fundamental science is accepted as the only means of solving the various problems that are presented. In human nutrition the investigator thinks and works in terms of animal physiology and biochemistry. If he did not, his work would become a stilted rule-of-thumb proposition. In plant pathology a knowledge of plant physiology is just as essential as a knowledge of mycology. By understanding the physiology of the organism and the physiology of the host plant, the best methods of control can be evolved that would take years of experimentation to discover.

In the field of agronomy itself the two most aggressive divisions, soils and plant breeding, have outstripped crop experimentation, in that they are accepted by the scientific world as scientific subjects. This is due to the fact that the fundamental sciences have been applied by the investigators to the solution of the problems. In soil management the investigator will have a chemical, physical, and bacteriological laboratory second only to the research laboratories in the pure sciences.

While the plant breeder was following rule-of-thumb methods, he by accident secured some valuable varieties of crop plants. As the problem became more complex, he had to apply the science of genetics, cytology, mycology, etc., so that now he attacks his problem in a scientific manner.

Interpretation of Experimental Results in the Light of Plant Physiology

In crop experimentation the problem of seed, seed treatment, rates and dates of seeding, have been experimented with by almost every experimenter working with almost every crop. Each experimenter has usually obtained different results with every crop. The result is that each one has a different recommendation, which, as a matter of fact, if the

physiology of the plant under the different environments was understood instead of the results being apparently contradictory, would be concordant. For example, take the question of the effect of size of seed on the resulting crop. Some investigators have indicated that it makes little or no difference to the resulting crop, while others find that it does influence the yield. If the physiology of germination and seeding growth had been applied to this, it would show that the results, instead of being inconsistent, were really consistent.

In the rate of seeding tests there is often great divergence in recommendations. Again the knowledge of the physiology of the tillering plant would make this data intelligible.

In some sections, early seeding of some crops is recommended, while in adjacent districts, later seeding seems to give better results. A study of soil temperature, soil moisture, and the physiology of germination would give a clue to the reason.

A study of the physiology of the wheat plant affected by rust and also of the rust organism would settle the difference of opinion in regard to the proper stage of maturity at which rusted wheat should be harvested. Some excellent work has been done in the study of the cause of winter hardiness and frost resistance in the cereal crop. With this information, the results of some field work with winter crops becomes intelligible.

Many more illustrations might be cited to show the value of plant physiology in the explanation of field data, but the above will suffice to show it might be applied to field work that has already been done.

It is to the future field experimentation work that plant physiology will be of the greatest use. As mentioned previously many of the early experiments gave quite consistent results. But when finer distinctions have to be made the difference cannot be so great and apparent contradictory results are more often obtained. As an example, sow thistle control might be mentioned. It is now conceded by most experiment stations that t bare fallow is the best method of contr The results in regard to the time when cul vation is most effective are inconsistent. Pla physiology in a study of the composition the roots at different periods of growt might explain the inconsistency.

In the past, yield per acre has been t measure of the effectiveness of differe methods of crop management; in the futu quality of product will become more impo ant. This will mean an intensive study the factors influencing quality and incident ly, study of technique for determining qu ity. While a great mass of data has be compiled on the factors influencing quali in wheat, we are not yet sure why one fie gives a wheat of high protein content and adjoining field, a wheat of low protein co tent. An intensive study of the physiolo of the plant for a few years would expla this. With other crops, the agronomis knowledge is still less exact. With m crops, differences in quality have not be determined. The need, therefore, of t field crop experimenter of the future, a knowledge of plant physiology, so that can apply it to the solution of the field pro lems.

Summary

1. Since crop experimentation began the seventeenth century, plant physiology h often been the means of explaining fie phenomena.

2. In the industries, fundamental scienc have been employed to explain the facto phenomena.

3. Many conflicting recommendatio would be eliminated if the cause of field sults were considered in the interpretatio

4. With more complex problems confro ing the crop experimenter, the results will less emphatic, and consequently, it will more necessary to understand the physiolo of the plant.

The Identification and Control of Adult Lepidopterous Insects Attacking Stored Products.

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The loss caused by insects in stored grains nd their products is of huge proportions each ear, but inasmuch as the presence of the ests is more often than not unsuspected, or noticed, ignored because of their inconspicuousness, the damage is likely in most ases to be overlooked or at least greatly disounted. Insects feeding in stored products re rarely observed as most of them work eneath the surface of the grain etc., or even nside the seeds. For this reason much of ne injury is caused without the presence of ne insects being suspected and it is only hen they have increased enormously that ney attract attention and create alarm, reulting in the demand for information leadng to their control.

The chief pests of stored products are lepiopterous insects (the larvae of moths) and eetles (adults and larvae). The first of nese are discussed in this paper but the ontrol measures suggested are used in the estruction of all insects infesting grains, ored food products, etc.

As a general rule adult specimens of lepioptera reared or found in stored products re submitted for determination in such conition as to render only a tentative deterination possible. Usually the wings are so adly rubbed that the markings are indistinct nd very frequently they are so badly damged that the venation is largely destroyed, which case even a generic determination is ot possible. In order to determine the species accurately, it has, therefore, been necesary to base the determinations upon some ructure not subject to injury. The male enitalia offer the most satisfactory means f doing this and by the employment of this naracter it is possible to identify the speces concerned with absolute certainty. The ositive determination of a species is not nly a matter of satisfaction, but is of conderable value as it may have an important earing upon the methods necessary to comat the pest.

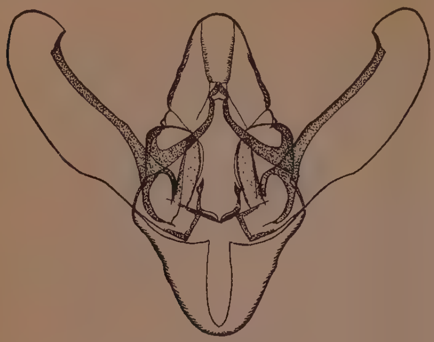
The disastrous results attending the establishment of foreign pests in North America, as evidenced by the damage occasioned by such insects as the European Corn Borer, San Jose Scale and Codling Moth, to mention only three of the pests which have attracted attention in Canada, renders it necessary that insects intercepted on imported merchandise be not only accurately, but quickly determined, in order that forms likely to become injurious in Canada might be recognized and the necessary action taken.

Insects not already established in the country must be looked upon with suspicion until it is known whether or not their habits are such as to preclude their establishment in Canada or that they be shown to be noninjurious. In the case of introduced moths, the question usually resolves itself into the consideration of whether the insects can stand our climate but this factor must be largely discounted in dealing with insects attacking stored products, owing to the fact that they may become serious pests in warehouses and mills where the temperature is sufficiently high during the winter to allow the insects to live in at least a dormant state.

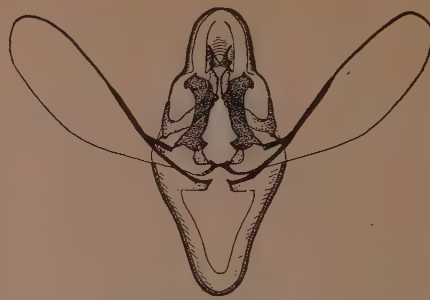
There are half a dozen lepidopterous insects frequently or occasionally met with in imported grain, nuts and dried fruits, coming under the head of stored products. Of these, two species are to be considered as major pests already established in Canada, two others occur in the country, but are not, as a rule, serious pests but might become so under ideal conditions, a fifth is undoubtedly established in Canada but has so far usually been found only in imported figs, while the sixth is a very important pest of grain in the United States and various parts of the world where the winters are less severe than in Canada.

Preparation of Genitalic Slides

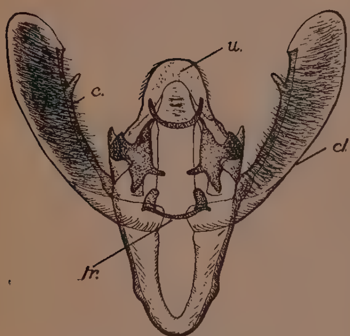
In order to study the genitalia it is necessary to at least treat a portion of the abdomen



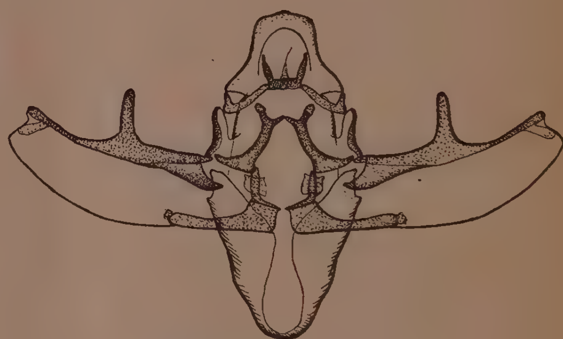
① E.KUEHNIELLA.



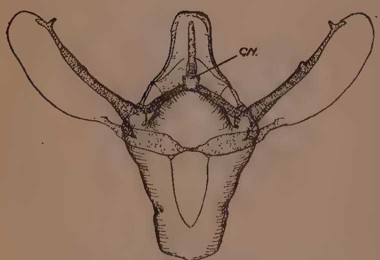
② E. ELUTELLA.



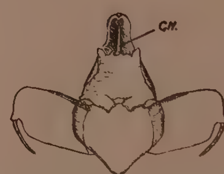
③ E.CAUTELLA.



④ E.FICULELLA.



⑤ P.INTERPUNCTELLA.



⑥ S. CEREALELLA.

Explanation of figures of male genitalia

Note: The hairs on the claspers have been drawn only in figure 3. In all cases except fig. 6 they are very similarly arranged. The aedoeagus is omitted in all drawings.

Fig. 1. *Ephestia kuehniella.*

Fig. 2. " " *elutella.*

Fig. 3. " *cautella.*

Fig. 4. *Ephestia figulella.*

Fig. 5. *Plodia interpunctella.*

Fig. 6. *Sitotroga cerealella.*

c.—Costa.

cl.—Clasper.

gn.—Gnathos.

tr.—Transtilla.

u.—Uncus.

in caustic potash and remove the scales from the vicinity of the genitalia. The preparation of a temporary or permanent slide is to be recommended, the following method being most satisfactory:

1. Cut off at least half the abdomen and place in 10% caustic potash over night, (8 to 16 hours).

2. Transfer to 70% alcohol, brush off scales and remove portions other than genitalic parts.

3. Transfer to 95% or absolute alcohol for at least 1 hour.

4. Transfer to oil of cloves in which the genitalia may be spread.

5. Mount in fairly thick Canada balsam.

When determination only is desired a temporary slide may be made by eliminating the oil of cloves and using glycerine instead of balsam or the determination may be made without mounting by merely removing the scales in 50% alcohol, spreading the genitalia and comparing with permanent slides.

Determination of Species

As the main object of this contribution is the determination of injurious moths attacking stored products, no attempt is made to differentiate the genera nor to deal with the classification. The disposition of the forms discussed in their respective families and genera is that at present accepted.

In making the determination it is necessary to remember that no two slides will appear quite the same owing to different perspective. It is thus necessary to compare those portions of the genitalia which are typical of a species, taking a general view of the structure. If one could view the parts "in situ" there would not be the variation evidenced in spread mounts, the spreading and mounting often resulting in the loosening of parts so that they may appear quite different in shape from those shown in the figures and it is, therefore, necessary either to turn the specimen so that the same view is obtained or to consider the relationship of its position in comparison to the figures. On the whole, however, there will be a general conformity which renders determination a simple matter.

KEY TO SPECIES BASED UPON MALE GENITALIC STRUCTURE

1. Claspers bearing a strong finger-like production on costa .... 2.
   Claspers with at most strong tubercle on costa .... 3.
2. Finger-like costal production situated at middle of clasper (fig. 4) .... *Ephestia figulella* Greggs.
   Finger-like process situated at apical fourth of costa (fig. 3) .... *Ephestia cautella* Walker.
3. Claspers sub-rectangular, with a long spur on the ante-costal edge of apex (fig. 6) .... *Sitotroga cerealella* Oliv.
   Claspers elongate, more or less rounded apically and lacking long spine .... 4.
4. Costa strongly widened on basal half, without apical or pre-apical production (fig. 2) .... *Ephestia elutella* Hbn.
   Costa strongly widened to apex, with apical or pre-apical spur .... 5.
5. Costal spur apical, costal swelling (when visible) well before the middle, gnathos composed of paired process (fig. 1) .... *Ephestia kuehniella* Zell.
   Costal spur pre-apical; costal tubercle (when visible), situated beyond middle; gnathos composed of a single process (fig. 5) .... *Plodia interpunctella* Hbn.

FAMILY PHYCITIDAE

Ephestia kuehniella Zeller

(Mediterranean Flour Moth. Fig. 1)

The Mediterranean flour moth is undoubtedly the most serious lepidopterous pest of stored products occurring in Canada. It is found chiefly in flour mills, and during the summer increases in numbers to such an extent as to sometimes cause the shutting-down of the mill in order to remove the webs made by the larvae. While the amount of flour consumed by the caterpillars is not noticed, they spin a silken thread wherever they crawl and these fine strands, which collect flour and hold it in the corners of the "chutes", finally break loose and are conveyed to the sifters which they choke. The caterpillars may feed in any part of the mill where the flour or grain dust lodges.

In addition to being a mill pest, this insect is very frequently found in the household, having been conveyed thence in flour, either as an egg or young caterpillar. It is not, however, a serious pest as its presence is likely to be soon noticed and the caterpillars destroyed. It also feeds to a limited

extent on stored grains and their products as well as nuts.

The male genitalia are illustrated in Fig. 1.

Ephestia elutella Hübner.

This species occurs occasionally in Canada. It attacks nuts, etc., and has been reared from linseed at Kaslo, B.C., by J. W. Cockle. It is found in all parts of Canada.

The genitalia are shown in Fig. 2.

Ephestia cautella Walker

The name "Fig Moth" has been used to designate this species but this name seems unsatisfactory as the species is most commonly found, at least in Canada, in nuts such as almonds and walnuts, although Forbes states that it is most commonly found in figs. It also attacks dates to a certain extent. It may at times become a serious pest in places where shelled nuts are stored during the summer and early autumn but most of them are killed off during the winter, fresh infestations being due chiefly to importations.

The genitalia are shown in Fig. 3.

Ephestia figulella Gregson

The larvae of this species have so far been found in Canada only on imported figs and may be distinguished from allied species by the presence of five fine, longitudinal, purplish or reddish lines, which are sometimes faint and soon disappear in preservatives. In Jamaica it has been reared from oatmeal and Forbes reports it as injurious to dried fruits. Like the preceding, it is not a serious pest, and is only occasionally found.

Plodia interpunctella Hübner

(The Indian Meal Moth)

In Canada the Indian Meal Moth ranks next to the Mediterranean flour moth in destructiveness. It often proves a serious pest in seed houses where it feeds on grains of all kinds, as well as their products, but flour is rarely attacked. In addition, nuts and dried fruits are equally acceptable as food, and the species is well established in Canada. Like the species of *Ephestia*, the larva spins a silken thread wherever it travels and the upper grains as well as the containers may be quite covered by the webs.

The genitalia are shown in Fig. 5.

GELECHIIDAE

Sitotroga cereallela Olivier

(The Angoumois Grain Moth)

This species has not become established in Canada and it is not likely that it will do so. It is found commonly in the middle and southern states and attacks standing as well as stored grains. It is frequently met with in corn imported from South America.

The genitalia are shown in Fig. 6.

PYRALIDAE

Pyralis farinalis Linnaeus.

(The Meal Snout Moth)

The Meal Snout Moth attacks cereals of all kinds which have become damaged due to moisture or other cause but does not attack clean stored grains or their products.

Control Measures

The control of the different species of lepidopterous insects attacking stored products is, in general, the same, but in view of the different conditions under which they occur various means of control may be practiced. In general, also, the recommendations will apply to all insects attacking stored products.

In the household where only small quantities are to be treated the simplest control is, in winter, to place the infested foodstuffs in a mouse or rat proof receptacle and expose them in a shed or even in the open. The pests will be frozen and killed. Where the temperature goes below zero, a single night should prove sufficient to kill any insects. It is, however, recommended that the foodstuffs be left in such a place for two or three days, especially if the temperature does not go below 20 deg. Fahr. While the receptacles are free of their contents they should be thoroughly cleaned and also placed outside in order to destroy any eggs which might be adhering to them.

During the summer, when pests are more liable to be in evidence the most satisfactory procedure is to place the foodstuffs in the oven for an hour or two at a temperature of 130 to 140 deg. Fahr. With small quantities of material the eggs and larvae will be quickly killed at this temperature. Flour so treated will be quite free from insects after sift-

ng and none the worse for the infestation or eating.

The treatment of nuts and fruits is necesarily different from that of grains and their products. In order to prevent the development of pests the fruit or nuts should be placed in cold storage. The usual cold storage temperatures are sufficiently low to prevent the development of the insects or fungus occurring in products from warm climates and a few weeks are sufficient to destroy the insect life. Small shipments of grain may be similarly treated.

Control of Insects in Mills and Warehouses

The satisfactory control of lepidopterous and other pests found in mills and warehouses can (so far as demonstrated) only be accomplished by superheating. By this is meant the maintenance of the temperature at a point above that at which insects can live. While fumigation is frequently recommended and is undoubtedly of great value, it has several disadvantages, the chief of which is the fact that none of the gases used will destroy the eggs, thus necessitating at least two applications within a month. Another disadvantage is the poor penetration of the gases employed and the tendency to drive the insects into the grain. Where heat is used not only are the eggs killed but the rising temperature induces great activtiy in the larvae and they come to the surface. Penetration is also much greater even though the behaviour of the insects renders this of less importance.

SUPERHEATING. The first step in the process of superheating is a thorough clean-up of the premises. All dust and accumulated refuse, cob-webs, etc., should be removed.

The temperatuure must be brought to between 120 deg. and 130 deg. Fahr. and held for at least 12 and preferably 18 hours. In case the temperature does not go higher than 120 deg. it should be held for at least 24 hours in order to ensure good results. In determining the temperature thermometers are placed in each room, one foot from the floor, and readings taken every hour or so to see that the required temperature is maintained.

One of the most important considerations in the use of heat is the outside temperature. A day should be chosen when the prospects are that the weather will continue warm for at least 24 hours and heating should not be commenced unless the outside temperature is over 70 deg. Fahr. With a temperature of 80 or 90 deg. outside it is not usually difficult to raise the temperature in the building to 125 deg.

If the installed heating equipment is not sufficient to raise the temperature to the required level, temporary pipes supplied with steam from a boiler, such as a threshing machine or steam roller may be used. Such piping might be permanently placed and the boiler secured whenever heating became necessary.

It is essential that the heat be up to 120 deg. Fahr. or higher on each of the floors. It should also be possible to close the openings between the different landings in order to insure that the lower floors are properly heated.

After heating, the machinery should be thoroughly oiled.

Heating of Seed Grain

The exposure of seed grain to a temperature of 125 to 130 deg. Fahr. for a greater period than six hours may, in some cases, injure its germination powers. As the essential factor of death due to heat lies in the contact of the insect with the heat for a short period, it is possible to destroy the insects in the grain by passing the material slowly through a heating machine at the temperature recommended. This will destroy the pests without injury to the grain which should then be stored in a building free of insects. If restored in an infested room, the moths present will quickly re-infest it.

FREEZING. While it is recognized that most insects attacking stored products in Canada can be destroyed by being exposed to a temperature of 0 deg. Fahr. for a few hours, or even at a temperature of 10 deg. Fahr. for eight to ten hours, the value of this means of control has not been fully demonstrated. In the first place, the evident absence or scarcity of insects during the winter is not conducive to the practice of control measures and at this season mills are run to capacity. Another objection is found in the necessity of draining water pipes and radiators, while the long time required to heat the machinery after freezing is a considerable drawback.

The fact that freezing is quite inexpensive and that it can be carried out during a week-end, commencing on Saturday noon and finishing early Monday morning quite offsets the disadvantages enumerated.

Freezing should prove to be of the greatest value in the control of lepidopterous insects and, if thoroughly done, will control all pests present. Certain grain weevils may be able to resist freezing providing they are present in moderate to large numbers in the middle of bins as they are able to generate sufficient heat to carry them through. This may be overcome by moving the grain so that it will all become chilled.

Freezing should be carried out at a temperature below 0 deg. Fahr.

Fumigation

As previously indicated, fumigation has several disadvantages; for instance it does not kill the eggs, the penetration is poor, the gases used are deadly poison and special equipment is necessary. There are, however, many cases when fumigation is the only practicable method and when proper precautions are taken there is no danger to human life. The prerequisite to fumigation is a thorough clean-up and scattering of the contents of the building as much as possible. The gas will only penetrate two or three inches into grain but as most insects are normally close to the surface, satisfactory control may be secured.

The temperature must be over 60 deg. Fahr. and 70 deg. or higher is better. It must be possible to close off the different floors as the gas goes upwards.

The most important facts to bear in mind are: to see that no one is in the building, that a guard is on duty at all times, that warning notices against entering the building are posted and that windows and doors may be opened from the outside after fumigation. The building must be as tight as possible and the weather calm. During a strong wind the gas will be driven from the windward side of the building and escaping gas may endanger persons in neighboring buildings.

The following are the materials required:

	Per 1000 cu. ft.
Sodium or potassium cyanide......	8 oz.
Commercial sulphuric acid	16 oz.
Water	40 oz.

Earthen or stoneware (never metal) containers—1 crock to each 3 or 4 thousand cubic feet.

The water should be placed in the crocks, the acid is then allowed to run slowly down the side of the container. The crocks should not be filled within eight or ten inches of the top. The cyanide is then measured into paper bags and tied. Distribute the crocks evenly about the rooms and place a bag of cyanide beside each. See that the building is closed except at the exit from each room and floor. Commencing farthest from the exit (on the top floor) drop the bags of cyanide gently into the liquid and move along the row or rows to the exit, closing the door tightly on leaving the room or floor. The same procedure is to be followed on each floor. Where two or three men are placing the paper bags in the liquid, they should move along at the same rate of speed so as to finish at the same time. *Never commence on a floor until the ones above have been finished.* For this reason it is essential that the men dropping the sacs on the upper floor shall complete the whole operation, working downwards. The building must be closed for at least 12 hours and preferably for 24 hours.

Do not allow anyone to enter the building until it has been well aired for several hours.

The refuse in the crocks should be buried or safely disposed of. Never throw it into sink or sewage as it will corrode the metal pipes.

As the eggs are not killed by fumigation it is necessary to repeat the operation in from two to three weeks.

A Proposed Revision of Dairy Barn Score Cards.

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INTRODUCTION by G. L. A. Ruehle, Michigan State College.

While the use of a score card as the sole system of judging of the quality of milk is to be deplored, there are occasions when its use is justifiable. Such an occasion arose last Spring while Mr. Shutt was taking graduate work with the writer. The managing head of a milk plant in Michigan requested that some one be sent to his plant for the purpose of inspecting and scoring the dairy farms supplying milk to the plant. He was assured that what was needed was a bacteriologist who could examine the milk itself. He answered that he expected to do this later but he wanted a preliminary survey made by the score card method, as he was just starting in as manager of the business and wanted to quickly appraise the sanitary condition of the farms supplying milk to the factory. Mr. Shutt was sent. Before going, the official score card was gone over carefully and such changes made as were thought desirable. After using the modified score card, further changes were found desirable and are embodied in the present paper.

During the past twenty years there have been many attempts to develop score cards for the inspection of dairy farms and dairy plants of various kinds. Within recent years there seems to have been a tendency to select the score card which was devised by a committee of the Official Dairy Instructor's Association and which is used by the United States Bureau of Animal Industry.

The farmers have a right to expect and demand that if a score card is to be used to determine the fitness of their methods and equipment for the production of milk, that it be revised from time to time to make it conform to the results of research work or experience. In as much as a great deal of work has been done since the last official score card was devised and no revisions have been made in recent years, the card as at present constituted is obviously out of date and in need of revision. In this paper the writer hopes to indicate some of the more obvious changes which seem desirable. It is hoped that others will interest themselves in this work and that revisions will be made frequently, so that the scores as determined in inspections shall represent judgment based on the latest scientific knowledge.

During the spring of 1925 the writer was requested by a large milk plant to make a survey of conditions upon farms supplying milk to them. The object in making this survey was not to judge the quality of the milk supply but rather to obtain accurate data concerning the equipment in use and the methods employed. The quality of the milk was to be determined later by a bacteriologist at the plant.

To accomplish this work to the satisfaction of all concerned it was deemed advisable to use some form of score card as a standard of comparison and as the writer was not satisfied with the official score card, another was drawn up and used. It was felt that the official score card tended to favor equipment rather than methods and that the final score as based on both equipment and methods gave no indication of the true state of affairs. Therefore a temporary score card was prepared. In this, an attempt was made to embody the ideas of the writer and Professor Ruehle as to the present knowledge of dairy sanitation, especially the viewpoint that methods are more important than equipment. Both the official and the revised cards (appended) were used for the inspection of 201 farms in Michigan and the results compared.

From the experience gained with these cards it was found that the final scores were misleading with both cards, in that it was possible to obtain the same final score with either good equipment and poor methods or poor equipment and good methods. With this criticism in mind it was felt that a separation of the two scores was desirable or even necessary from many points of view and that instead of a final score on both equipment

and methods a separate score for each be obtained. It was also felt that some further changes were necessary in the weightings, or individual scores, which had been assigned in the previous score card. These changes were therefore made with the results shown in the appended score cards, one for the sanitary inspection of dairy farm equipment and the other for the sanitary inspection of dairy farm methods, both being based on a total of 100 for a perfect score.

With such a set of cards it should be possible to be perfectly fair to the dairy farmer who is producing a high grade of milk with a very meager equipment which he may have inherited, or which he is unable to alter on account of being a tenant farmer. On the other hand, it will be possible to give recognition to the farmer who has the equipment which is deemed desirable.

It is unfortunate that the general opinion among dairy inspectors with respect to scores for dairy barns seems to be that a final composite score, which is made up of a score on methods and one on equipment is essential and that the two scores should be on one card for the purpose of filing. If this is desirable the writer suggests that the final score be computed from the individual scores of equipment and methods somewhat as follows:

Equipment 100
Methods 200
Total—300 divided by 3.............=100

This would mean one final score as in the past, but would require multiplying the score of methods by two, adding the result of the two scores and dividing by three.

It is easier for the inspector to score on the basis of percentage and it should prove of great educational value to the farmer to have the outstanding points brought visibly to his attention. With the official card much of the scoring is necessarily done in decimals which tends to minimize the specific criticisms and the educational value is largely lost.

It will be observed that in many respects the wording of the official card has been retained, merely the weightings or scores of the various items having been changed and that these changes have been made largely on the score card for methods. Daily exercise for cows has been recognized on the new card and not on the old. This is undoubtedly of value in maintaining the health of the animals. Other changes occur with respect to the handling of the milk.

It must be admitted that these new cards have not yet been used in actual scoring and it is entirely probable that still further changes may be necessary when put to use. Experience has convinced the writer however, that changes in the official card are desirable if a score card is to be used at all, since the score cards most in use fail to reflect the results of research on milk sanitation. The writer does not believe that any score card can be devised which will indicate accurately the safety of the milk for consumption. Proper methods of pasteurization must be relied upon for this purpose and then only when the process of pasteurization is efficiently controlled by intelligent inspection and supervision. Score cards should never be used for the sole purpose of deciding whether milk is to be accepted or rejected by the milk plant or to be sold in the city. The only justification for their use is as a means of educating the dairy farmer and assisting the inexperienced inspector to look for probable sources of factors which harm the keeping quality of the milk.

In conclusion the writer is fully aware of the many advantages of the official score card, not the least of which is its quite general use over the whole country. This enables comparisons to be made between different localities and many inspectors will therefore feel loth to accept changes which might result in the loss of this advantage. This feeling however, should not be allowed to interfere with changes suggested by the results of newer research. In any field of endeavor changes must be made from time to time if there is to be any progress. These changes are therefore submitted for the purpose of promoting discussion with the hope that some real progress may result.

ACKNOWLEDGEMENTS

The writer is indebted to the following for valuable criticism and advice: Mr. H. R. Estes, B.S., Dairy and Food Inspector for Flint, Michigan; Dr. W. H. Price, Detroit Creamery; Mr. T. H. Broughton, Director of Dairying, State of Michigan; and to Professor G. L. A. Ruehle, Michigan State College, whose valuable assistance made this paper possible.

CARD I.

UNITED STATES DEPARTMENT OF AGRICULTURE

Bureau of Animal Industry.

Dairy Division.

SANITARY INSPECTION OF DAIRY FARMS.

SCORE CARD

Indorsed by the Official Dairy Instructors' Association

Owner or lessee of farm..

P.O. Address ....State ....

Total Number of cows....................Number milking ....

Gallons of milk produced daily..

Product is sold by producer in families, hotels, restaurants, stores, to............dealer.

For milk supply of..

Permit No....................... Date of Inspection ....192..

(Signed) ....

INSPECTOR.

EQUIPMENT	SCORE Perfect	SCORE Allowed
Cows.		
Health	6	
Apparently in good health....1		
If tested with tuberculin within a year and no tuberculosis is found, or if tested within six months and all reacting animals removed....5		
(If tested within a year and reacting animals are found and removed, 3.)		
Food (clean and wholesome)	1	
Water (clean and fresh)	1	
Stables.		
Location of stable	2	
Well drained 1		
Free from contaminating surroundings 1		
Construction of stable	4	
Tight, sound floor and proper gutter..2		
Smooth, tight walls and ceiling 1		
Proper stall, tie, and manger....1		
Provision for light: Four sq. ft. of glass per cow	4	
Three sq. ft., 3; 2 sq. ft., 2; 1 sq. ft., 1. Deduct for uneven distribution.		
Bedding	1	
Ventilation	7	
Provision for fresh air, controllable flue system 3		
(windows hinged at bottom, 1.5; sliding windows, 1; other openings, 0.5.)		
Cubic feet of space per cow, 500 ft....3		
(Less than 500 ft., 2; less than 400 ft., 1; less than 300 ft., 0.)		
Provision for controlling temperature....1		
Utensils.		
Construction and condition of utensils	1	
Water for cleaning	1	
(Clean, convenient, and abundant.)		
Small-top milking pail	5	
Milk cooler	1	
Clean milking suits	1	
Milk Room or Milk House.		
Location: Free from contaminating surroundings	1	
Construction of milk room	2	
Floors, walls, and ceilings....1		
Light, ventilation, screens 1		
Separate rooms for washing utensils and handling milk	1	
Facilities for steam	1	
(Hot water, 0.5.)		
Total	40	

METHODS	SCORE Perfect	SCORE Allowed
Cows.		
Clean	8	
(Free from visible dirt, 6.)		
Stables.		
Cleanliness of stables	6	
Floor 2		
Walls 1		
Ceilings and ledges 1		
Mangers and partitions 1		
Windows 1		
Stable air at milking time	5	
Freedom from dust 3		
Freedom from odors 2		
Cleanliness of bedding	1	
Barnyard	2	
Clean 1		
Well drained 1		
Removal of manure daily to 50 feet from stable	2	
Milk Room or Milk House		
Cleanliness of milk room	3	
Utensils and Milking.		
Care and cleanliness of utensils	8	
Thoroughly washed 2		
Sterilized in steam for 15 minutes 3		
(Placed over steam jet, or scalded with boiling water, 2)		
Protection from contamination 3		
Cleanliness of milking	9	
Clean, dry hands 3		
Udders washed and wiped 6		
Udders cleaned with moist cloth, 4; cleaned with dry cloth or brush at least 15 minutes before milking,1)		
Handling the Milk.		
Cleanliness of attendants in milk room....	2	
Milk removed immediately from stable without pouring from pail	2	
Cooled immediately after milking each cow	2	
Cooled below 50 deg. F.	5	
(51 deg. to 55 deg., 4; 56 deg. to 60 deg., 2.)		
Stored below 50 deg. F.	3	
(51 deg. to 55 deg., 2; 56 deg. to 60 deg., 1.)		
Transportation below 50 deg. F.	2	
(51 deg. to 55 deg., 1.5; 56 deg. to 60 deg., 1.)		
(If delivered twice a day, allow perfect score for storage and transportation		
Total	60	

Equipment................. + Methods.............=.............Final Score.

Note 1.—If any exceptionally filthy condition is found, particularly dirty utensils, the total score may be further limited.

Note 2.—If the water is exposed to dangerous contamination or there is evidence of the presence of a dangerous disease in animals or attendants, the score shall be 0.

1st MODIFIED OFFICIAL CARD II.
SANITARY INSPECTION OF DAIRY FARMS

SCORE CARD

Owner or lessee of farm..
P. O. Address.................................. State..............................
Total number of cows..........................Number milking....................
Gallons of milk produced daily...
Product is sold by producer in families, hotels, restaurants, stores, to............dealer.
For milk supply of...
Permit No................Date of inspection..................................., 192...

EQUIPMENT	SCORE Perfect	SCORE Allowed
Cows.		
Health	6	....
Apparently in good health 1		
If tested with tuberculin within a year and no tuberculosis is found, or if tested within six months and all reacting animals removed..........5		
(If tested within a year and reacting animals are found and removed, 3.)		
Stables.		
Location of stable	2	....
Well drained 1		
Free from contaminating surroundings 1		
Construction of stable	4	....
Tight, sound floor and proper gutter..2		
Smooth, tight walls and ceiling 1		
Proper stall, tie, and manger..........1		
Provision for light: Four sq. ft. of glass per cow	4	....
Three sq. ft., 3; 2 sq. ft., 2; 1 sq. ft., 1. Deduct for uneven distribution.		
Bedding	1	....
Ventilation	6	....
Provision for fresh air, controllable flue system 3		
(windows hinged at bottom, 1.5; sliding windows, 1; other openings, 0.5.)		
Cubic feet of space per cow, 500 ft..........3		
(Less than 500 ft., 2; less than 400 ft., 1; less than 300 ft., 0.)		
Utensils.		
Construction and condition of utensils..	2	....
Water for cleaning	1	....
(Clean, convenient, and abundant.)		
Small-top milking pail....................	2	....
Milk cooler	2	....
Clean milking suits	1	....
Milk Room or Milk House.		
Location: Free from contaminating surroundings	1	....
Construction of milk room	2	....
Floors, walls, and ceilings..........1		
Light, ventilation, screens 1		
Separate rooms for washing utensils and handling milk	2	....
Facilities for steam	4	....
(Hot water, 3.)		
Total	40	....

METHODS	SCORE Perfect	SCORE Allowed
Cows.		
Clean	8	....
(Free from visible dirt, 6.)		
Stables.		
Cleanliness of stables	6	....
Floor 2		
Walls 1		
Ceilings and ledges 1		
Mangers and partitions 1		
Windows 1		
Stable air at milking time....................	2	....
Freedom from dust 1		
Freedom from odors..........1		
Cleanliness of bedding	1	....
Barnyard	2	....
Clean 1		
Well drained 1		
Removal of manure daily to 50 feet from stable	2	....
Milk Room or Milk House		
Cleanliness of milk room	5	....
Utensils and Milking.		
Care and cleanliness of utensils....................	10	....
Thoroughly washed 3		
Steamed for 15 minutes 5		
(Placed over seam jet, or scalded with boiling water, 4.)		
Protection from contamination 2		
Cleanliness of milking....................	9	....
Clean, dry hands 3		
Udders washed and wiped..........6		
(Udders cleaned with moist cloth, 4; cleaned with dry cloth, or brush at least 15 minutes before milking, 1.)		
Handling the Milk.		
Cleanliness of attendants in milk room..	2	....
Milk removed immediately from stable without pouring from pail	2	....
Provision for cooling	4	....
Provision for maintaining temperature during transportation	3	....
Milk delivered at 50 deg. F. or below..........	4	....
(If delivered twice a day, allow perfect score for storage and transportation.)		
Total	60	....

Equipment.................. + Methods............=.............Final Score.

Note 1.—If any exceptionally filthy condition is found, particularly dirty utensils, the total score may be further limited.

Note 2.—If the water is exposed to dangerous contamination or there is evidence of the presence of a dangerous disease in animals or attendants, the score shall be 0.

Remarks: ....

(Signed) ....

INSPECTOR.

SUGGESTED SCORE CARD III
SANITARY INSPECTION OF DAIRY FARM EQUIPMENT AND METHODS

SCORE CARD

Owner or lessee of farm...

P. O. Address.. Province..................

Total number of cows..........................Number milking....................

Gallons of milk produced daily...

Product is sold by producer in families, hotels, restaurants, stores, to............dealer.

For milk supply of...

Permit No................Date of inspection..........................., 192...

Suggested Score Card IIIa. Suggested Score Card IIIb.

EQUIPMENT	SCORE Perfect	SCORE Allowed
Cows.		
Health	18	
Apparently in good health 6		
If tested with tuberculin within a year and no tuberculosis is found, or if tested within six months and all reacting animals removed 12		
(If tested within a year and reacting animals are found and removed) 10		
Food (clean and wholesome)	1	
Water (clean and fresh)	1	
Stables.		
Location of stable	4	
Well drained 1		
Free from contaminating surroundings 3		
Construction of stable	7	
Tight sound floor and proper gutter 3		
Smooth, tight walls and ceiling 2		
Proper stall, tie and manger 2		
Used for cows only	3	
Provision for light: Four sq. ft. of glass per cow	4	
(Three sq. ft., 3; 2 sq. ft., 2; 1 sq. ft., 1. Deduct for uneven distribution.)		
Bedding	2	
Ventilation	7	
Provision for fresh air, controllable flue system 3		
(windows hinged at bottom, 1.5; sliding windows, 1; other openings, 0.5.)		
Cubic feet of space per cow, 500 3		
(Less than 500 ft., 2; less than 400 ft., 1; less than 300 ft., 0.)		
Provision for controlling temperature 1		
Utensils.		
Construction and condition of utensils	5	
Water for cleaning—Clean, convenient and abundant	4	
Small top Milking pail	3	
Milk cooler, (efficient). Ice or equivalent	7	
Clean milking suits	4	
Proper storage	2	
Milk Room or Milk House.		
Location: Free from contaminating surroundings and convenient	7	
Construction of milk room	10	
Floor, walls and ceiling 5		
Light, ventilation, screens 5		
Separate rooms for washing utensils and handling milk	1	
Facilities for steam	10	
Boiling water 7		
Total score	100	

METHODS	SCORE Perfect	SCORE Allowed
Cows.		
Clean (free from visible dirt—10)	15	
Daily exercise	5	
Stables.		
Cleanliness of stables	8	
Floor 2		
Walls and Windows 2		
Ceilings and Ledges 2		
Mangers and partitions 2		
Stable air at milking time	2	
Freedom from dust 1		
Freedom from odors 1		
Cleanliness of bedding	2	
Barnyard	2	
Clean 1		
Well drained 1		
Removal of manure daily to 50 feet from stable or to manure shed	5	
Milk Room or Milk House.		
Cleanliness of milk room	10	
(Cut heavily if used for any other purpose).		
Utensils and Milking.		
Care and cleanliness of utensils	15	
Thoroughly washed 4		
Sterilized in steam for 15 minutes 7		
(Placed over steam jet, or scalded with boiling water—5)		
Protection from contamination 4		
Cleanliness of milking	11	
Clean, dry hands 6		
Udders washed and wiped before milking 5		
(Cleaned with moist cloth—4; Cleaned with dry cloth at least 15 minutes before milking—1.)		
Handling the Milk.		
Cleanliness of attendants in milk room	2	
Milk removed immediately from stable without pouring from pail	3	
Cooled immediately after milking each cow	2	
Provision for cooling to 50 deg. F. within 1 hour after milking	6	
Provision for maintaining temperature during storage and transportation at 50 deg. F.	6	
Milk delivered at 50 deg. F. or below	6	
(If delivered twice a day, allow perfect score for storage and transportation)		
Total	100	

Note No. 1.—If any exceptionally filthy condition is found, particularly dirty utensils, the total score may be further limited.

Note No. 2.—If the water is exposed to dangerous contamination, or there is evidence of the presence of a dangerous disease in animals or attendants, the score shall be 0.

Remarks: ....

(Signed) ....

INSPECTOR.

Fig. 1. The comparison between a healthy plant and extreme witches' broom development, on Early St. George potato plant. (Photo by H. McL.)

Fig. 2. Extreme witches' broom development on a Netted Gem potato plant. (Photo loaned through the courtesy of B. F. Dana, Pullman, Wash.)

Witches' Broom of Potatoes.

H. R. McLARTY

Dominion Experimental Station, Summerland, B.C.

A disease known as Witches' Broom is reported from British Columbia where some damage has been caused in commercial plantings. The distinguishing characteristics of this trouble are first,—extreme dwarfing and yellowing of the plants grown from diseased tubers (Fig. 1); the great masses of fine, much branched stems (Fig. 2); the production of an almost innumerable number of small tubers which are usually found to be sprouting and sending up new stems. (Fig. 3).

Additional characteristics which might cause it to be confused with other diseases are first,—in newly affected plants, a rolling of the leaves quite similar to that of Leaf Roll; and secondly, the presence of aerial tubers quite similar to those caused by Rhizoctonia.

Little is known as to the spread of the disease, but there is indication that spread occurs slowly from plant to plant in the field. With careful roguing of all the diseased plants and careful selection of the tubers, the disease should not become severe.

Fig. 3 Prolonged stolon development with formation of successive tubers on a Netted Gem potato plant. (Photo loaned through the courtesy of B. F. Dana, Pullman, Wash.)

La Revue Agronomique Canadienne

RÉDACTEUR—H. M. NAGANT

La Pathologie Végétale en France.

RICHARD BORDELEAU

St. Thècle, P.Q.

La pathologie végétale occupe actuellement une place importante en agriculture, elle s'est développée très rapidement durant les deux derniers siècles et il est intéressant d'en suivre les progrès dans tous les pays.

Nous traiterons ici de l'organisation de cette branche de l'agriculture en France, et nous dirons quelques mots de ceux qui ont travaillé à son avancement dans ce pays.

I

ORGANISATION ACTUELLE DE LA PHYTOPATHOLOGIE EN FRANCE

Les établissements où l'on s'occupe de cette science peuvent se répartir en trois groupes:

1—Etablissements du Ministère de l'Agriculture.

2—Etablissements du Ministère de l'Instruction Publique.

3—Etablissements privés.

I—Etablissements du Ministère de l'Agriculture

Ces établissements sont d'une part les Stations de Recherches, d'autre part les Laboratoires d'enseignement.

Stations de Recherches

a—*Station Centrale de Phytopathologie et de Parasitologie agricole de Paris.*

En 1887 Prillieux créa le laboratoire de pathologie végétale à l'Institut National Agronomique. En 1898 cette Station fut transférée sur la rue Alési. Se sont succédés dans cette station comme directeurs, Delacroix, Prillieux et, depuis 1915, Et. Foex, lequel occupe encore ce poste. En 1921 cette station était attachée à l'Institut des Recherches Agronomiques lequel fut crée à cette époque. Toutes les Stations et les Laboratoires du Ministère de l'Agriculture y furent annexés. En plus de Maublanc, Joffrin, Arnaud, déjà dans le service, y entrèrent en 1923 les préparateurs suivants, Melles Barfut, adjointe à Arnaud pour s'occuper de l'herbier, Gaudineau et M. Guyot. La première s'occupe de la bibliothèque et effectue en même temps, avec M. Guyot, des recherches sur les maladies du blé. En cette même année la Station de Pathologie Végétale de Paris prit le nom qu'elle porte actuellement, celui de Station Centrale de Phytopathologie et de parasitologie agricole de Paris. Cette station sera bientôt transférée à Versailles dans un nouveau local.

b—*Station de Pathologie Végétale de Brive.*

En 1921, Dufrenoy entra dans le service et se consacra plus particulièrement à l'étude de la maladie de l'encre du chataignier. Afin de lui permettre d'effectuer ses recherches en plein foyer de maladie, une station fut crée à Brive (Corrèze).

c—*Station de Pathologie Végétale de Bordeaux*

La Station de Recherches Viticoles de Cadillac (Gironde), qui a été illustrée par les travaux de Capus a, en 1913, été transformée en Station de Pathologie Végétale, laquelle après la guerre, fut transférée à Grande Ferrade près Bordeaux. En 1923 Capus fut élu député et remplacé par Gard qui est spécialement intéressé dans les maladies de la vigne et du noyer.

—*Station de Pathologie Végétale d'Antibes*

Antibes (Alpes-Maritimes) une Station de athologie Végétale a été annexée à l'Institut es Recherches Agronomiques. Cette Station st sous la direction de M. Poirault.

Est en outre, en principe, annexée à la haire de Botanique de chacune des Ecoles ationales d'Agriculture de Grignon, Montellier et Rennes une Station de Pathologie égétale.

De plus, un phytopathologiste existe dans hacun des Centres, Stations Agronomiques u d'Avertissements de Metz, Nancy, Colmar, ijon, Clermont-Ferrand, Avignon, Bel-Air t Montpellier.

Le directeur de la Station Centrale de aris est chargé d'assurer la coordination du avail.

Chaires et Laboratoires d'enseignement

La pathologie végétéale est enseignée à Institut National Agronomique dans une haire magistrale occupée par M. G. Fron, ui dispose d'un laboratoire d'enseignement t de recherches.

Dans les Ecoles Nationales d'Agriculture, a pathologie végétale est enseignée par le rofesseur de Botanique, à Grignon par ucomet, à Montpellier par Khunoltz-Lordat, Rennes par Duboys. Dans ces écoles, l'nseignement et les recherches phytopathoogiques s'effectuent dans les laboratoires de otanique.

La pathologie végétale est également enignée par les professeurs de Sciences Natrelles dans les Ecoles Pratiques d'Agriculire.

2—Etablissements du Ministère de L'Instruction Publique

Bien qu'aucun cours de pathologie végétale e soit professé au Muséum, son étude a tours tenu une certaine place, aussi bien dans enseignement que dans les laboratoires. 'est naturellement surtout au laboratoire de ryptogamie que ces recherches de pathologie égétale ont été effectuées.

Cette science entre dans le programme enseignement des chaires de Botanique agriole des Universités, Elle est notamment prossée par Gain à l'Université de Nancy, Everardt à l'Université de Besançon, Decrock à Université de Marseille, Prunet à l'Université de Toulouse, Daniel à l'Université de Rennes.

Certains professeurs de Botanique qui s'intéressent personnellement aux questions de pathologie végétale entreprennent des recherches sur ce sujet dans les diverses Universittés où ils sont appelés à enseigner. Tel est le cas de Beauverie qui a fait des travaux sur les maladies des plantes à Lyon, Clermont-Ferrand. Tel est également le cas de Fernand Moreau qui a successivement étudié les maladies du houblon à Nancy et celles des céréales à Clermont-Ferrand.

Villedieu à l'Ecole de Médecine et de Pharmacie de Tours a fait sur les anticryptogamiques une série d'études dans lesquelles il conclut à la non toxicité du cuivre. Fronze-Diacon, professeur à la Faculté de Pharmacie de Montpellier et bien d'autres encore ont discuté les travaux de Villedieu et combattu ses conclusions. La polémique a duré plusieurs années.

3—Etablissements privés

Vermorel, fabricant de matériel agricole, a son laboratoire de pathologie végétale à Ville-Franche sur Saône. D'importantes recherches ont été effectuées par Vermorel lui-même ou en coopération avec ses assistants Dantony et Zolostarewsky, sur les insecticides et les fongicides.

La Maison Truffault, de Versailles, possède un laboratoire où l'on s'occupe surtout de biologie du sol, mais certains travaux sont faits sur les anticryptogamiques. Ce laboratoire est nous la direction de Nicolas Bezssanoff. Vilmorin et Cie., marchands grainetiers, possèdent à Verrières un laboratoire de pathologie végétale où travaille M. Simonet.

Du reste, plusieurs autres fabricants d'insecticides et anticryptogamiques ont des laboratoires d'étude.

Sociétés en rapport avec la Phytopathologie

1—La Société Mycologique de France, fondée en 1885, a largement contribué à assurer le développement de la pathologie végétale en France. Elle a, en effet, permis aux phytopathologistes d'entrer en rapport avec les mycologues et de publier leurs travaux. On trouve dans le bulletin de cette Société, des Mémoires importants sur les maladies

des plantes, signés par Prillieux, Delacroix, Mangin, etc.

2—La Société de Pathologie Végétale fut fondée en 1914, sous l'égide de Prillieux, président honoraire, et sous la présidence effective de Mangin. Cette Société reçut dans ses cadres tous ceux s'intéressant à la Pathologie végétale; Et. Foex est secrétaire général de cette société.

3—La Société de Pathologie Comparée, surtout composée de médecins et de vétérinaires, fait quelquefois paraître des travaux sur la phytopathologie.

4—La Société de Biologie accorde une certaine attention, dans son Bulletin, à la pathologie végétale.

5—Les Annales de l'Institut Pasteur ont parfois publié des travaux sur les maladies des plantes, tels ceux de Laurent, Pinoy, Magrou, Picado, etc.

6—La Société de Zoologie de Bordeaux insère des articles de pathologie végétale dans sa revue.

7—Il va sans dire que certains travaux de pathologie végétale sont présentés sous forme de communications à l'Académie des Sciences et à l'Académie d'Agriculture.

II.

CEUX QUI SE SONT OCCUPÉS DE PHYTOPATHOLOGIE EN FRANCE

Au XIX siècle.

Les premiers travaux publiés en France sur la pathologie végétale sont dus à Benédict Prévost dont le mémoire paru en 1808 sur la carie du blé est remarquable par la précision avec laquelle sont décrits la morphologie et le cycle biologique du Tilletia caries. Il a étudié avec beaucoup de soin l'action qu'exercent les solutions de sulfate de cuivre sur le Tilletia caries et s'il n'a pas inventé la méthode des traitements cupriques des semences, déjà utilisé avant lui, il en a expliqué le mécanisme et l'a préconisé. Il eut le sort de beaucoup de précurseurs, il ne fut ni compris ni suivi. On peut dire que ce sont les grands mycologues qui se sont succédés en France au cours du XIX siècle: Desmazières, Montagne, Tulasne, Léveillé, De Seynes, Cornu, Boudier, Patouillard, qui ont tracé et ouvert la voie aux phytopathologues.

D'autre part les découvertes de Pasteur ont attiré l'attention sur le rôle considérable jo par les infiniment petits (bactéries, champi nons). En outre, Pasteur a fourni des mét odes d'étude et de recherches dont ont bén ficié les phytopathologistes français. L'a parition successive des terribles fléaux q ont frappé la vigne (Oidium, Phylloxer Mildiou, Black-Rot) a longuement contrib à orienter le zèle des recherches en pathol gie végétale.

Oidium de la vigne, causé par l'Uncinu necator, est le premier en date, vers 1847, d parasites étrangers introduits sur notre so En 1853, de La Vergne et H. Marès divu guaient les notions du soufrage des vign (méthode déjà employée en Angleterre e 1846 par Kyla, jardinier à Lyton; en Franc en 1850 par Duchartre et Hardy). En 18 le soufrage entrait réellement dans la pra que, grâce à de Marès qui avait étudié l'a tion du soufre sur l'Oidium dans ses rappor avec le développement du parasite et avait p tracer les règles du soufrage.

Mildiou de la vigne, causé par le plasm para viticola, fut observé pour la premiè fois en France par Planchon en 1878. Cet maladie a été étudiée par Cornu, Millard Prillieux, Viala. C'est à Millardet que r vient le très grand mérite d'avoir conçu mis au point la méthode de traitement co tre le Plasmopara viticola, par l'emploi de bouillie bordelaise.

Anthracnose de la vigne, causée par Gloeosporium amphelophagum, est une ma adie fort ancienne, elle a été étudiée p Cornu, Prillieux et Viala.

Le Pourridié des racines de la vigne a é l'objet d'une importante monographie p Viala, qui a en coopération avec Boyer pu lié en outre un magistral traité sur les mala ies de la vigne.

La maladie de l'Encre des Chataignie causée par le Melanconis modonia, déva depuis une cinquantaine d'années les ch aigneraies françaises. Planchon, Delacro Mangin, Crie et beaucoup d'autres ont étu spécialement cette maladie.

Les maladies des céréales. Prillieux consacré plusieurs importants travaux a maladies des céréales. En coopération a Delacroix, il a travaillé sur une maladie blé causée par l'Ophiobolus graminis. P lieux et Fréchou ont aussi travaillé sur

'eronospora setariae. Delacroix et Prillieux ont fait une intéressante étude du champignon Endoconidium temulentum, qui donne au eigle des propriétés vénéneuses.

Les maladies de la pomme de terre. Cette plante d'une grande importance économique a attiré l'attention d'un excellent agronome, Girard, et du naturaliste Roze. Ce dernier a écrit en 1898 un ouvrage intitulé "L'histoire de la pomme de terre". Dix ans avant la publication de Roze, Prillieux avait fait connaître qu'il était possible de lutter contre la brulure tardive de la pomme de terre par l'emploi de la bouillie bordelaise.

Parmi mycologistes qui ont fait des travaux de pathologie végétale nous pouvons citer particulièrement: Cornu dont les travaux sur les Péronosporées, les Ustilaginées, les Urédinées, l'Antrachnose de la vigne et la Brulure tardive de la pomme de terre sont bien connus; Boudier, célèbre par sa classification des Discomycètes d'Europe; Patouillard, par ses recherches sur les Hyménomycètes et les Polyporées.

Au XX siècle.

Prillieux.

A l'Académie des Sciences aussi bien qu'à l'Académie d'Agriculture, Prillieux était considéré comme le représentant des phytopathologistes français. Par ses oeuvres il appartient plus au XIX siècle qu'au XX siècle. En effet, en 1900, il avait 70 ans. A cette époque sa vue ne lui permettait plus de faire d'études micrographiques, mais il resta jusqu'a sa mort directeur de la Station de Phytopathologie de Paris, s'intéressant à tous les travaux en cours, suggérant des idées au sujet des expériences et proposant de nouveaux thèmes de recherches. Sa mémoire restée fidèle lui permettait de rappeler à ses collaborateurs ses plus anciennes observations ou publications. Il a publié une foule de travaux touchant à tous les problèmes de pathologie végétale.

Delacroix.

Dévoué collaborateur de Prillieux, Delacroix fit preuve d'une activité remarquable jusqu'à sa mort en 1907. Il étudia plus particulièrement les maladies du tabac. Il s'occupa aussi avec succès de l'étude des maladies des plantes des pays chauds. La mort l'empêcha de publier un livre sur ce sujet, mais la préparation en était fort avancée. Une portion de cet ouvrage parut dans "L'Agriculture des pays chauds". Il a écrit deux traités sur les maladies des plantes. Son esprit d'observation, la sureté de son coup d'oeil et une oeuvre scientifique considérable lui ont assuré une place élevée dans l'estime du monde savant. L'utilité pratique de ses travaux a rendu de signalés services aux cultivateurs de toutes les régions de la France et aux colons des pays tropicaux.

Hariot.

A publié plusieurs mémoires de pathologie végétale, on lui doit en particulier un excellent traité sur les Urédinées.

Patouillard.

Il remplaça Camus au Muséum. En coopération avec Mangin, il publia de nombreux travaux sur la phytopathologie.

Mangin.

Actuellement membre de l'Institut et directeur du Muséum, Mangin occupe la chaire de cryptogamie, ce qui ne l'empêche pas de consacrer beaucoup de temps à la pathologie végétale. Il a fait d'intéressantes étude sur divers sujets, entre autre sur la maladie de l'Encre du Chataignier.

Prunet.

Professeur de Botanique agricole à l'Université de Toulouse, Prunet a fait d'importantes études sur les maladies de la vigne et en particulier sur la Black-Rot. Il a mis au point les procédés de lutte contre ce parasite. Il a également fait des recherches sur la maladie des Perches du Peuplier de la Caroline causée par le champignon Dothichiza populnea. C'est lui qui le premier a songé a reconstituer les chataigneries françaises en employant comme porte-greffe le chataignier: var. Castanea crenata qui est résistant à la maladie de l'Encre.

Viala.

Propriétaire viticulteur, en rapport par son enseignement de l'Institut Agronomique, par son journal "La Revue de Viticulture" et par ses relations, avec tout le monde viticole français, Viala est considéré comme une grande autorité en matière de viticulture. Il poursuit depuis une vingtaine d'années des recherches sur l'Esca, maladie de la vigne causée par le Fomes igniarius et d'autres Polyporés. Certaines de ses interprétations, telles que celles concernant les rapports entre les levures et les Gloeosporium ont donné

lieu à de vives discussions auxquelles Guilliermond, dont les beaux travaux sur les levures sont bien connus, a pris une large part.

Ravaz.

Tandis que Viala poursuivait ses expériences à Paris, Ravez, à Montpellier, continuait d'importantes études. En contact direct avec les vignerons, viticulteur lui-même, il sait très bien quelles sont les exigences de la pratique, ce qu'elle attend de la science et ce que cette dernière doit s'efforcer de lui donner. Les travaux que Ravaz a publiés depuis 1900 touchent à toutes les questions de viticulture. Il a notamment conçu et réalisé un système d'avertissement, basé sur les époques de germination des spores et de contamination, qui permet aux viticulteurs de la région de Montpellier d'effectuer leurs traitements en temps voulu et de ne pas pulvériser leur bouillie en pure perte.

Capus.

Il a institué pour la région de Bordeaux des systèmes d'avertissements du même ordre que ceux de Ravaz. Observateur émérite qui a eu l'idée d'employer en plein champ les méthodes rigoureuses de laboratoire, Capus s'est livré pendant de nombreuses années à l'étude des conditions favorisant ou permettant le développement du Plasmopara viticola et du Guignardia Bidwelli. Il a fort bien mis en évidence les relations entre le parasite et son hôte. Député de la Gironde, Capus fut en 1924 nommé Ministre de l'Agriculture et dut abandonner ses recherches sur les maladies de la vigne.

Gard.

C'est à Gard, chargé de cours à la Faculté des Sciences de Bordeaux, qu'incombe le soin de poursuivre les études entreprises par Capus. On lui doit des études sur les conditions de germination des conidies et des zoospores du Plasmopara viticola ainsi que sur le mécanisme d'action des traitements cupriques.

Boyer.

Professor de Botanique à l'Ecole Nationale d'Agriculture de Montpellier, Boyer, observateur attentif et sagace, s'est toujours efforcé de découvrir la vérité scientifique dont il a la religion; Il fit des recherches sur les maladies de l'olivier, du mûrier, sur une Téléphorée vivant sur la vigne, l'Hélicobasidiu purpureum.

Griffon.

Directeur adjoint de la Station de Phyto pathologie, de 1909 jusqu'à sa mort en 191 Griffon a publié de nombreux travaux, soi seul ou en collaboration avec Maublanc, Foe ou Berthault. Il a essayé de vérifier expéri mentalement si, ainsi que l'a affirmé Danie professeur de Botanique agricole à l'Univer sité de Rennes, la greffe aboutit à une véritabl hybridation. Ses études sur ce sujet le con duisirent à des conclusions sensiblemen différentes de celles de Daniel.

Fron.

Professeur de pathologie végétale à L'In stitut National Agronomique, Fron a, soi avec Prillieux, soit avec Van Tieghem, pub lié de nombreux travaux. Il a travaillé su les maladies du Groseiller, sur une maladi des branches du Cotonnier et sur une Chy tridinée parasite de la Luzerne.

Maublanc.

Chef des travaux de botanique et de patho logie végétale à l'Institut National Agrono mique, Maublanc est également secrétair général de la Société Mycologique de France Dans de nombreux travaux il a été le colla borateur de Prillieux, Delacroix, Griffon. D retour de Brésil, Maublanc s'occupe surtou des maladies des plantes coloniales.

Ducomet.

Professeur à l'Ecole Nationale d'Agricul ture de Grignon, Ducomet est célèbre par se travaux en botanique agricole, génétique e surtout en pathologie végétale. Il a travaill sur la brunissure de la vigne et d'autres vég taux. Peu après il entreprenait des étude sur les champignons à thalle sous-cuticulair A Rennes, Ducomet fut amené a étudier l maladie de l'Encre du Chataignier. Depu 1910, il se consacre tout particulièrement au maladies de dégénérescence de la pomm de terre. Son travail a surtout été engagé a point de vue pratique. Il a essayé de dégage des lignées indemnes, cultivé des variét étrangères, a fait des semis et des hybrid tions. Ducomet s'est beaucoup occupé d l'action qu'exercent les conditions de mi ieu sur les maladies de dégénérescence. D puis deux ans, il s'occupe des maladies d céréales, il a entrepris d'importantes étud

ur les rouilles, leur mode d'hivernation et a résistance des variétés.

'oex.

Depuis 1915, Foex est directeur de la tation de Phytopathologie de Paris. Ses remières recherches ont porté sur les Rouiles des céréales. Depuis 1924, il a repris ur de plus larges bases une étude d'ensemble ur la résistance à la rouille d'un certain ıombre de blés qui ont été semés dans onze tations différentes. Partout les semis et les bservations sont effectués suivant le même ılan qui a été dressé en collaboration avec Ducomet. Il a aussi étudié les deux piétins lu blé, il a pu préciser les conditions de ermination des ascospores d'Ophiobolus raminis et Leptosphaeria herpotrichoides. .a lutte contre le piétin semble devoir s'engager par trois voies différentes: traitement l'acide sulfurique, amélioration des conditions de nutrition de la plante, emploi de 'ariétés résistantes. Depuis la guerre, en ollaboration avec Ducomet, Foex a étudié es maladies de dégénérescence de la pomme le terre, il a essayé de se rendre compte dans uelle mesure les maladies de dégénérescence ont transmissibles par le tubercule de semence. Il a étudié en particulier l'enroulement et la leptonécrose. Ses essais lui ont ıermis de constater que la filosité n'est pas ransmissible par le tubercule et est par conséquent une affection tout à fait différente des naladies de dégénérescence. Il a aussi poursuivi des recherches sur les Erysiphacés en énéral et en particulier sur celui qui a causé le si grands dégâts sur les chênes.

Arnaud.

Directeur adjoint de la Station de Phytoıathologie de Paris. Ses principaux travaux ont des études sur les fumagines ordinaires, ur les fumagines parasites, sur les maladies lu mûrier, sur la biologie du Nectria cinnabarina, sur le Bacterium mori. Il a publié de ıombreuses notes sur les champignons parasites divers.

Bernard.

Par les conceptions qu'il a émises au sujet les transitions existant entre le parasitisme et a symbiose, au sujet aussi du mécanisme d'action de celui-ci, les travaux de Bernard intéressent au plus haut point les phytopathoogistes. On sait comment ce savant a cru devoir généraliser sa théorie au point qu'il est arrivé à un moment donné à émettre l'avis que toute tubérisation a pour origine une infestation des racines.

Magrou.

Chef de laboratoire de l'Institut Pasteur, Magrou reprit les travaux de Bernard et s'efforça de démontrer expérimentalement que l'infestation des racines joue un grand rôle dans la production du phénomène de tubérisation. Il étudie, depuis quelque temps, le "crown gall"; il a encore été publié peu de choses sur ce sujet. Ont cependant paru dans "La Presse Médicale": un Essai sur l'étiologie du cancer; dans les Annales de l'Institut Pasteur: Recherches expérimentales sur le cancer des plantes; dans la Revue de Pathologie Végétale: Tumeurs expérimentales dues au Bacterium tumefaciens. Magrou a été le collabonateur de Pinoy dont les beaux travaux sur les Myxomycètes et sur les bactéries des Légumineuses sont classiques.

Beauverie.

Professeur à Lyon, il s'est occupé de la maladie de la toile qui s'attaque aux semis, il a ainsi pu révèler que cette dernière n'était qu'une forme stérile du Botrytis cinéréa. Il a étudié les maladies du pêcher dans la vallée du Rhône. Dans les galeries creusées par les insectes à i'intérieur des arbres fruitiers, Beauverie a découvert ces curieuses formes fongiques nommées Ambrosia qui sont des productions tératologiques en relation avec les traumatismes subis.

Maire.

A été surtout un mycologue, mais s'est beaucoup occupé de pathologie végétale. Ses travaux dans ce dernier domaine sont sur les Plasmodiophorées, les Urédinées. Depuis qu'il réside en Algérie, il est souvent consulté au sujet des maladies des plantes qui sévissent dans cette contrée.

Chifflot.

De la Faculté de Sciences de Lyon, Chifflot a publié de nombreuses notes sur les maladies des plantes horticoles et fruitières.

Moreau.

A étudiéé a Clermont-Ferrand les maladies du houblon. Moreau s'intéresse actuellement à la génétique du blé, dont il étudie aussi les maladies.

Nous devons mentionner ici quelques noms de cytologistes et mycologistes ayant contribué largement au développement de la pathologie végétale en France tels, Dangeard, Sappin-Trouffy, Molliard, Matruchot, Constantin, Noffray, Lème, Perret, Blaringhem et Séverin.

Nos sincères remerciements vont à ceux qui nous ont aidé pour la rédaction de cet article et en particulier à M. Etienne Foex, directeur de la Station de Phytopathologie de Paris, qui a bien voulu nous envoyer les références nécessaires.

BIBLIOGRAPHIE

La Revue des Eleveurs.

Nous accusons réception du premier numéro de cette publication nouvelle qui promet de faire époque dans l'histoire du développement de la presse agricole de la province de Québec.

Imprimée sur bon papier, d'un format de neuf pouces sur douze, avec ses trente deux pages de texte, elle produit une impression très favorable dès le premier abord. Dans la présentation de son programme, la direction annonce que la nouvelle revue, outre sa spécialisation dans l'élevage, réservera une section spéciale à la médecine vétérinaire, ouvrira ses colonnes à ceux qui s'occupent de l'exploitation du renard argenté, et même aux experts dans l'élevage des chiens. Non contente de cela, la direction se propose encore d'élargir plus tard les cadres et d'y introduire notamment une page pour le foyer, de manière à intéresser les dames et les jeunes filles dans une lecture à la fois instructive et agréable.

Au sommaire de ce premier numéro, nous voyons une liste d'articles qui annonce un contenu vraiment substantiel. Mentionnons: "L'élevage en progrès", par l'hon. J. Ed. Caron, ministre de l'agriculture de la province de Québec; "Une publication opportune" par le Dr. F. T. Daubigny, directeur de l'Ecole de médecine vétérinaire; "Répartition de notre industrie animale", par J. R. Rousseau, I. A.; "Le Cheval," par J. J. Gautreau, B.S.A.; "Les porcs et moutons", par X. N. Rodrigue, B.S.A.; "La médecine vétérinaire", par le Dr. J. A. E. Bédard.

En plus de ceci, il y a encore lieu de mentionner deux articles non signés, intitulés respectivement: "L'Elevage du renard", et "Nos troupeaux accrédités", ainsi que sous le titre de "Divers": Les renards argentés—Les volailles—Le chien de chasse—Les fourrures—Recettes et conseils, etc., etc.

Nul doute que cette revue consacrée exclusivement à une branche si importante de notre agriculture stimulera l'intéret pour l'élevage sous toutes ses formes dans la province. On sait qu'il y a encore beaucoup de progrès à accomplir en cette matière, aussi peut on dire que la "Revue des éleveurs" arrive en son temps pour en être un des facteurs de premier ordre.

Pour abonnement, on s'adressera: "La Revue des Eleveurs", Enregistrée, 109½, rue Crémazie, Québec. Prix: un dollar par an pour 12 numéros.

Concerning the C.S.T.A.

CONVENTION REPORT

It was impossible to prepare a complete port of the Sixth Annual Convention in ne for this issue. The August issue will erefore publish the Presidential Address Dean E. A. Howes, the annual report of e General Secretary, reports of standing mmittees and a synopsis of all business ansacted. A number of photographs taken the Convention will also be reproduced in e next issue.

For the information of members, however, may be stated that the annual fee was duced from $6.00 to $5.00, applicable to l fees due on June 1, 1926. The initiation e of $5.00 remains in effect, but does not ply to graduates who join within one year ter graduation, or to former members who in again before December 31, 1926.

The total attendance at the Ottawa Conntion was approximately two hundred and enty-five.

NOTES

C. T. Townsend (British Columbia '25) ho has just completed a year of graduate ork at Macdonald College, is with Caulder's eamery at Weyburn, Saskatchewan.

P. C. Kidd, formerly Dairy Commissioner the Saskatchewan Department of Agrilture, is with the De Laval Separator ompany at Winnipeg.

E. L. Eaton (O.A.C. '20) has been appoint- Agricultural Representative at Bridgeater, N.S.

The address of I. F. Stothers (O.A.C. '23) 310 12th St. East, Prince Albert, Saskatewan.

J. F. Booth (Saskatchewan '19) has been anted the Ph.D. degree at Cornell Univery and has accepted an appointment with the U. S. Department of Agriculture at Washington, as Agricultural Economist.

P. H. Ferguson (O.A.C. '20) has been appointed Registrar of Co-operative Associations in the Manitoba Department of Agriculture at Winnipeg.

J. E. D. Whitmore (O.A.C. '26) is with the Cereal Division at the Central Experimental Farm, Ottawa.

R. P. Charbonneau (Syracuse '23) has been appointed Field Representative for the Holstein Freisian Association of Quebec. He was formerly Asst. Superintendent of the Dominion Experimental Station at Ste. Anne de la Pocatière, P.Q.

W. E. Senn (O.A.C. '23) has been appointed Agricultural Representative at Fort William, Ontario, and Fraser Ross (O.A.C. '22) transferred from Fort William to Simcoe, Ontario.

C. K. Johns (Alberta '25) has completed a year of graduate work at Macdonald College and is now with the Dairy Branch of the Alberta Department of Agriculture at Edmonton.

T. C. Vanterpool (Macdonald '23) has returned to Macdonald College after a year's graduate training in Botany at the University of Manitoba.

G. L. Landon (British Columbia '23) has been appointed District Poultry Instructor under the B.C. Department of Agriculture, with headquarters at Nelson, B.C.

K. A. Harrison (O.A.C. '24) has been appointed as Assistant Plant Pathologist at the Dominion Laboratory of Plant Pathology, Kentville, N.S.

The second re-union of Macdonald College graduates was held at the College from June 28th to July 1st. About eighty-five graduates were in attendance, and every class

from the first class in 1911 to the last graduating class in 1926 was represented. It is expected that the next re-union will be held in 1932.

The University of Alberta has published a second edition of Bulletin No. 10, "Binder and Knotter Troubles", by Prof. J. Macgregor Smith. Since the publication of the first edition a year ago, many new cuts have been obtained. The second edition is most profusely illustrated and will be invaluable to farmers during the harvesting season. It contains 75 illustrations and 80 pages.

APPLICATIONS FOR MEMBERSHIP

The following applications for regular membership have been accepted since May 1, 1926:—

Andrew, J. F. (Toronto, 1923, B.S.A.) Vermilion, Alta.

Ballantyne, J. P. S., Kapuskasing, Ont.

Biggar, Earl (Toronto, B.A.) Mount Pleasant, Ont.

Coltart, T. H. (Manitoba, 1921, B.S.A.) Winnipeg, Man.

Dawson, J. A. (Toronto, 1923, B.S.A.) Ottawa, Ont.

Forsyth, Fred (Toronto, 1914, B.S.A.) Perth, Ont.

Fortier, Pascal, La Ferme, P.Q.

King, K. M., (Montana, 1920, B.Sc., 1926, M.Sc.) Saskatoon, Sask.

Lemieux, O. A., (Toronto, 1926, B.S.A.) Ottawa, Ont.

Mather, W. J., (Saskatchewan, 1926, B.S.A.) Saskatoon, Sask.

Meek, C. M. (Toronto, 1922, B.S.A.) Carp, Ont.

McKee, D. (Toronto, 1913, B.S.A.) Toronto, Ont.

Owen, C. W. (McGill, 1925, B.S.A.) Ottawa, Ont.

Smith, Wm. (Aberdeen, 1923, B.Sc., (Agr.) Saskatoon, Sask.

Thomas, D. H. (Alberta, 1925, B.S.A.) E monton, Alta.

BUREAU OF RECORDS AND EMPLO MENT.

During the recent Convention a speci committee gave consideration to the deta of organization of the above Bureau, and the advisability of opening it as a Socie activity. From the information gathered to the time of the Convention, it appear that more interest was being taken in t establishment of the Bureau by employe than by members of the Society. Out of total of over 900 members to whom registr tion cards had been sent last April, less th 400 had been returned by June 15th, a not more than 50 of these wished to reg ter in the Employment section.

The recommendation of the Committee w that the work of compiling records be pr ceeded with, and that when there appear to be sufficient interest shown by the me bers, the Bureau be declared open for a plications from employers and recommend tions for vacancies.

1927 CONVENTION

The next annual Convention of the S iety will be held at Vancouver, in Ju 1927. The Canadian Seed Growers' Assoc tion will meet there at about the same ti

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MEMBERSHIP CAMPAIGN

The General Secretary will undertake Dominion-wide membership campaign, co-operation with local branches, about end of August. In the meantime memb can assist materially by encouraging n members either to join the Society or write to the General Secretary for particul

Sixth Annual Convention.

'he Sixth Annual Convention of the Can-an Society of Technical Agriculturists, d at Ottawa from June 23rd to 26th, 1926, admitted to be the most representative hering of professional agriculturists that ever been held in Canada. The attend-e was approximately two hundred and nty-five, twice as large as the attendance any previous convention of the Society. ery province in the Dominion was repre-ted, the largest representation being nat-lly from the provinces of Ontario and ebec.

'he business meetings were presided over Dr. G. C. Creelman, Beamsville, Ontario, vly elected President of the Society, who ceeded E. A. Howes, Dean of the Faculty Agriculture at the University of Alberta. e retiring address of Dean Howes is pub-ed elsewhere in this issue.

'he report of the General Secretary, also blished in this issue, indicated that the iety was making definite progress, in-asing its membership, improving its fin-ial condition and commanding the respect l consideration of all those interested in advancement of agriculture in Canada.

Reports of Standing Committees given at recent Convention were particularly val-ble and several of these reports show that portant fields of inquiry have been thor-ghly covered and that definite recommenda-ns can now be made. Members of the iety do not appear to appreciate the vast ount of work which has been done during past five years by the members of these nmittees but it may be stated that this rk is among the most valuable contribu-is which the C.S.T.A. is making to agri-ture.

During the Convention a number of ad-ced lectures were delivered through the rtesy of the Dominion Department of riculture, and it is expected that these will published in *Scientific Agriculture* within next few months. Those who contribut-to this lecture programme were: Dr. F. B. rrison, Professor of Animal Husbandry, iversity of Wisconsin, Dr. D. F. Jones, nt Breeder at the Agricultural Experiment tion, New Haven, Conn.; Dr. C. L. Metcalf, f. of Entomology, University of Illinois; Dr. Wm. Crocker, Director of the Boyce-Thompson Institute for Plant Research at Yonkers, N.Y., and Dr. T. U. H. Ellinger, Economist of the International Live Stock Exposition, Chicago.

Complimentary luncheons were tendered to the Society, during the Convention, by the Ontario Department of Agriculture, the Central Experimental Farm and the Kiwanis Club of Ottawa. On Saturday, June 26th, following a visit to the Experimental Farm, a party of about one hundred and twenty-five motored to the Agricultural School at Kemptville, Ont., where they were received and entertained by Principal W. J. Bell and his staff.

One important change had to be made in the programme as published early in June. Senator Arthur Capper of Topeka, Kansas, found it impossible to leave his work at Washington to address the Convention at a banquet on June 25th, and at rather short notice this function was cancelled and substituted by a dance which, under the circumstances, was entirely successful and provided relaxation from strenuous business meetings.

In order to add to the entertainment of those attending the Convention, the Publicity Committee, largely through the efforts of its Chairman, Mr. E. T. Chesley, published a daily paper, *The Morning Muddler*, which, as its name implies, was anything but serious in its policy but which was a definite contribution to the Convention.

In addition to the Presidential address of Dean Howes and the report of the General Secretary, the following pages contain: (1) The report of Standing Committees on Educational Policies, Marketing Education, Graduate Study and Affiliations, (2) the personnel of all committees for 1926-27, (3) Resolutions passed, 4) Amendments to Constitution and By-laws, (5) Reports of Convention Committees dealing with the Bureau of Records and Employment and with the operating policies of the Socitety's official organ and (6) other information arising out of the business meetings. The report of the Committee on Research was not ready for presentation at the Convention and will not be available for publication for some little time.

CONVENTION COMMITTEES

On the opening day of the Convention the following Committees were appointed to meet during the Convention and to report on the closing day:

RESOLUTIONS: E. A. Howes (Chairman), H. G. Crawford, C. F. Bailey, J. E. Montreuil, M. P. Tullis.

CONSTITUTION: J. W. Gibson, (Chairman), G. R. Wilson, R. S. Duncan, G. LeLacheur.

PUBLICATIONS: E. F. Palmer (Chairman), F. E. Buck, L. E. Kirk, F. M. Clement.

NOMINATIONS: G. P. McRostie (Chairman), L. S. Klinck, A. A. MacMillan, G. G. Moe, L. H. Newman.

BUREAU OF RECORDS: J. B. Reynolds, (Chairman), W. C. McKillican, B. L. Emslie, A. P. MacVannel, H. M. Nagant.

The reports of these Committees, as presented on June 25th were as follows:

Resolutions Committee

1. WHEREAS it is recognized that the success of the Sixth Annual Convention of the Canadian Society of Technical Agriculturists has been due in large measure to the magnificent assistance rendered the society by other organizations,

THEREFORE BE IT RESOLVED that the hearty thanks of the members and delegates assembled in the Sixth Annual Convention of the C.S.T.A. be tendered:

1. To the Dominion Department of Agriculture for its invaluable cooperation and assistance and in arranging for the series of splendid lectures.

2. To the Department of Agriculture of the Province of Ontario for the entertainment at luncheon on June 24th.

3. To the officers in charge and the staff of the Central Experimental Farms System and the Kemptville Agricultural School for their courtesy and entertainment.

2. WHEREAS invaluable assistance has been accorded the Society in holding this convention by others not so directly interested in professional agriculture—

THEREFORE BE IT RESOLVED that the hearty thanks of the members and delegates be tendered:

1. To the Kiwanis Club of Ottawa, for its entertainment at luncheon on June 25th.

2. To the Chateau Laurier Management f providing all the meeting rooms for t convention.

3. To the Modern Press Publishing Co pany and the Crabtree Company of Otta for printing the *Morning Muddler* grat

3. WHEREAS, the success of the sixth conve tion has rested primarily upon the Easte Ontario Branch of the C.S.T.A.

THEREFORE BE IT RESOLVED that t unstinted praise and thanks of the membe and delegates present be tendered to the Ea ern Ontario Branch as a whole and in pa ticular to the local committees—Programn Entertainment, Registration and Publicit for their untiring and successful efforts the service of the society.

4. WHEREAS the continued progress of t C.S.T.A. in this the sixth year of its histo has been conspicuous,

AND WHEREAS this progress has be to a degree impossible of calculation due the tireless activities of the General Secreta

THEREFORE BE IT RESOLVED that t President express to Mr. Grindley before t assembled members and delegates the rec nition by the Society of this fact.

5. WHEREAS the library facilities ma available to the Agricultural workers in Ca ada by the Dominion Department of Agric ture have proved most valuable,

THEREFORE BE IT RESOLVED that Society express its appreciation of the serv rendered technical workers in Agriculture Canada through the generous loan and inf mation service provided by the Dominion partment of Agriculture in the Library the Department.

6. WHEREAS a new department of the w of the Society has been made possible thro the generosity of the Chilean Nitrate Co mittee,

THEREFORE BE IT RESOLVED that C.S.T.A. thank most heartily the Chil Nitrate Committee (B. Leslie Emslie) fo grant of $1,000.00 to cover the expense organizing a Bureau of Records and Empl ment.

7. WHEREAS the following resolution been received from the British Colum Branch of the C.S.T.A.

BE IT RESOLVED that the matter "Recognition by the Department of Justi be referred to the incoming Executive w

power to act and with the suggestion that the matter be brought to the attention of the Dominion Executive, with the idea of having technical agriculturists in good standing officially recognized as being in the professional class.

8. WHEREAS the following resolution has been received from the British Columbia Branch of the C.S.T.A.

BE IT RESOLVED that it is in the best interests of the Society that the General Secretary should visit each province at least once a year, and, where possible, this visit should coincide with the annual meeting of the branches and that the importance of this should be brought to the attention of the General Convention and an attempt made to make financial arrangements necessary to carry this out.

9. WHEREAS the colonization of rural districts is essentially a part of agricultural development in which the Canadian Society of Technical Agriculturists is primarily interested.

AND WHEREAS the Society is directly concerned in retaining in Canada the services of agricultural graduates from Canadian Universities.

AND WHEREAS on the advice of technical agriculturists The Soldier Settlement Board developed a field supervision system embracing expert advice in land and live stock selection and after care of settlers, in which system a large number of agricultural graduates were utilized and formed the main structure.

AND WHEREAS in subsequent and more general colonization activities such as the British Family Settlement Scheme and the Foreign Family Settlement Scheme, the Board, as the land settlement agency, has adhered to the same general principles of field supervision and still maintains a large number of agricultural graduates,

THEREFORE BE IT RESOLVED that this Society heartily endorse the statement of the Honourable the Minister of Immigration made in the House of Commons on March 25th, in discussing the Act for the settlement of Crown lands, viz:

> "I do not see any reason for being "alarmed about the administration costs, "because we already have a thoroughly "trained organization in the field, the Sol- "dier Settlement organization, and that is "the organization I purpose using,"

and recommends to the Dominion Government that the services of the same organization be used in the appraisal of lands in connection with the rural credits legislation.

AND FURTHER BE IT RESOLVED that this Society earnestly recommends to the Dominion Government that any further necessary appointments in connection with field supervision as applied to colonization, land settlement and rural credit projects, be made from the agricultural graduates of Canadian institutions.

AND FURTHER BE IT RESOLVED that a copy of this resolution be sent to—

The Prime Minister of Canada,
The Minister of Immigration and Colonization,
The Minister of Agriculture,
The Minister of Railways, and
The Leaders of the Conservative and Progressive Parties.

Constitution Committee

This Committee made only one change to the Constitution of the Society, namely the deletion of all reference to Associate members, leaving only three classes of members, namely: Regular, Student and Honorary.

It should be pointed out that applications for Associate membership were not permitted after June 1, 1924, and that since that time all Associate members accepted prior to June 1, 1924, have been promoted to Regular membership. Hence there is no further need for any provision for Associate members.

Amendments were made to the By-laws reducing the annual fee from $6.00 to $5.00, with an initiation fee of $5.00 still effective. The amendment provides, however, that no initiation fee need be paid by (a) those who make application for membership within one year after graduation, (b) those now in arrears who make application for re-instatement prior to January 1, 1927 and (c) mem-

bers of affiliated societies who join within twelve months after affiliation or after they become members of affiliated societies.

A clause was added to the By-laws defining the basis upon which scientific societies may be acepted as affiliations, namely, that at least 75 per cent. of their eligible members have been duly admitted to membership in the C.S.T.A.

As a result of these additions and amendments to the By-laws of the Society, it is intended to carry on a membership campaign as soon as possible, in the hope that many eligible members will take advantage of the reduction in the annual fee and that those not required to pay the initiation fee will become identified with the Society.

Publications Committee

The report of the Publications Committee was as follows:—

The work of this Committee resolves itself into a discussion of three general problems, as follows:—

1. Editorial policy.
2. Revision of Editorial Committee.
3. Advertising.

Dealing first with the question of editorial policy, the suggestion of your committee would be to adopt definitely a policy of maintaining the high standard of technical articles now being published in *Scientific Agriculture.* The necessity of maintaining such a standard is probably evident to all and need not be amplified further in this report.

In addition to the continuance of publication of such material the committee would suggest the preparation of a series of articles of an educative nature dealing with the various research problems being carried on at the experiment stations and agricultural institutions throughout Canada. The purpose of these articles would be to acquaint all members of the C.S.T.A. with the work and problems of brother-workers at other institutions and in other provinces.

It is suggested that technical articles might carry greater appeal to the average reader if an introductory paragraph, prepared by a competent member of the editorial board, were included in the issue carrying the article, though probably not to be printed on the same page with the article itself, but rather grouped separately with other similar introductory paragraphs. The content of such paragraphs would be submitted to the author of the article.

It is further suggested that *Scientific Agriculture* might be enlarged and improved by securing the active co-operation of the various Universities and Departments of Agriculture. To this end the following suggestions are made:—

(a) That the universities and other agricultural institutions such as the Federal and Provincial Departments of Agriculture, be approached with a view to supplying articles along scientific lines and along other lines already indicated.

(b) All these contributing agencies to supply one article per year, to be carried in every other issue of the magazine, which articles would be to all intents and purposes a write-up of such institutions.

(c) That in addition a half page advertisement of contributing universities be carried in all issues of the magazine.

(d) That in exchange, and since this increase in the size of *Scientific Agriculture* will require a considerably increased revenue, estimated at $3000.00, these instiuttions and departments be approached with a view to contributing annually the necessary funds.

2. The committee suggests that some revision of the editorial board be made in order to give greater assistance to the editor, such revision to be left in the hands of the Dominion Executive.

3. That since the maintenance of the magazine as a self-supporting publication is solely dependent upon adequate advertising revenue, an attempt be made to establish personal contact between influential members of the Society and commercial firms with which these members have business dealings. In this way a request for advertising support would probably have a more desirable result than is to be expected under present conditions when the appeal is apparently a strictly commercial one.

Nominations Committee

This Committee nominated the following Standing Committees for the coming year:—

Research: G. P. McRostie, (Chairman), J. F. Snell, J. M. Swaine, H. Barton, E. S. Archibald.

Affiliations: L. H. Newman (Chairman), T. G. Major, Arthur Gibson.

DUCATIONAL POLICIES: L. S. Klinck (Chairman), H. S. Arkell, H. A. Craig, M. Cumming, Charles Gagné, F. C. Harrison, E. A. Howes, W. C. McKillican, Father Leopold, J. B. Reynolds, W. J. Rutherford.
ARKETING EDUCATION: A. A. MacMillan, (Chairman), C. W. Baxter, W. Waldron, P. E. Light, F. M. Clement, J. A. Ruddick, C. P. Marker, S. E. Todd, A. Leitch, J. B. Cloutier, Dan Johnson, J. K. King.

The Committee on Graduate Study was not -appointed. The report of this Committee commended that the Dominion Executive rovide ways and means for one member of e Society to endeavour to put into effect e findings and recommendations of this ommittee.

SUB-COMMITTEES

In addition to the Standing Committees on esearch, Affiliations, Educational Policies nd Marketing Education (printed above), e following Committees were appointe by the Dominion Executive: (Chairman all cases is named first).

O-ORDINATION OF AGRICULTURAL POLICY: E. A. Howes, F. M. Clement, F. H. Auld, W. C. McKillican, W. B. Roadhouse, H. Barton, L. P. Roy, M. Cumming, Jas. Bremner, Jr., H. S. Arkell, G. H. Clark.
INANCE: B. L. Emslie, J. P. Sackville, Omer Caron.
EMBERSHIP: A. R. Milne, L. E. Kirk, P. Stewart.
ALLOTS: L. C. McOuat, H. G. Crawford.
XECUTIVE COUNCIL: G. C. Creelman, H. S. Arkell, L. P. Roy, L. H. Newman, P. Stewart, B. L. Emslie, H. M. Nagant, E. A. Lods.
DITORIAL BOARD: Elsewhere in this issue.
epresentative on Council of A.A.A.S.: (To be appointted.
CHOLARSHIPS: G. C. Creelman.
UDITORS: L. H. Newman, P. Stewart.
ENERAL SECRETARY: Fred. H. Grindley.

Committee on Bureau of Records and Employment

The report of this Committee was as folws:—

(1) That immediate steps be taken to omplete registration in the Records Section.

(2) That a Board of Directors, to consider pplications and recommendations for emloyment be appointed.

(3) That when, in the opinion of the Board of Directors, the registration in the Records Section is sufficient to warrant operation, the Bureau of Employment be opened to receive applications and to make recommendations.

These three recommendations were made after the Committee had discussed fully with the General Secretary the progress so far made in the organization of the Bureau. It was apparent that members of the Society were not inclined to furnish information promptly to the Records Section and that persistent efforts would have to be maintained in order that the records of all members might be obtained. Comparatively few members appeared to be interested in the Employment Section and it was not considered advisable that this section should operate until registration in the Records Section had been completed .

On the other hand, numerous letters received from employing institutions and read to the Convention, appeared to indicate a considerable interest in the establishment of the Bureau and in most cases expressed a hope that organization work would be completed and the Bureau opened.

Committee on Affiliations

The report of the Standing Committee on Affiliations, presented by Mr. L. H. Newman, was as follows:—

During the past year the C.S.T.A. has become affiliated with the British Association for the Advancement of Science and with the Agricultural Education Association of Great Britain.

The basis upon which the C.S.T.A. may accept other societies of a scientific or semi-scientific nature into affiliation has never been defined and since the Society now finds itself in need of some definite and explicit basis upon which to act your Committee has given the matter considerable consideration. In this connection we beg to submit two recommendations, viz:

(1) That no Society, otherwise eligible, which seeks affiliation with the C.S.T.A., shall be admitted into affiliation unless at least seventy-five per cent of the members of such Society who are eligible for membership in the C.S.T.A. have applied for such membership and have been duly admitted and elected.

(2) That members of affiliated societies, applying for membership in the C.S.T.A., shall not be required to pay any initiation fee to the Society, provided they apply for membership within twelve months after affiliation or within twelve months after they become members of affiliated societies.

Applications for affiliation from the Western Canadian Society of Agronomy and the Western Canada Society of Animal Production have been received by the General Secretary and your Committee begs to recommend that these two applications be accepted, providing the two Societies referred to comply with the foregoing requirements.

Following the adoption of this report a clause was drafted and added to the By-laws of the Society, covering the basis upon which scientific societies would be admitted into affiliation.

C.S.T.A. Fellowship

The C.S.T.A. Fellowship for 1926, the highest honour in the gift of the Society, awarded for professional distinction, was conferred upon William Lochhead, Emeritus Professor of Entomology, McGill University.

Professor Lochhead was born at Listowel, Ontario, on April 3, 1864. He received his B.A. degree from McGill University in 1885, and his M.Sc. from Cornell in 1895. He was Science Master in the Collegiate Institutes at Galt, Perth, and London, Ont., before joining the staff of the Ontario Agricultural College in 1898. He occupied the position of Professor of Biology at the O.A.C. for 8 years, being appointed to a similar chair at Macdonald College when that institution was opened in 1906. He remained in charge of the Biology Department until 1920, when the Department was divided. From 1920 until he recent retirement he filled the position of Professor of Entomology and Zoology. Illness forced him out of active work a few months ago, but he remains officially identified with Macdonald College as Emeritus Professor of Entomology, an honour bestowed upon him by his Alma Mater, McGill.

Only a few months ago, a portrait of Professor Lochhead, painted by G. Horne Russell, P.R.C.A., on subscription of his colleagues, pupils, associates and friends, was hung in the library of Macdonald College. A copy of this portrait is reproduced on the opposite page.

Professor Lochhead and Mrs. Lochhead a residing at Ste. Anne de Bellevue, close the gates of Macdonald College. Membe of the C.S.T.A. will unite in wishing the happiness and long life.

EASTERN CANADA SOCIETY OF ANIMAL PRODUCTION

During the recent Convention of t C.S.T.A. a meeting of those interested Animal Husbandry was held in the Chatea Laurier, for the purpose of discussing t organization of an Eastern Canada Society Animal Production, similar to the one o ganized for Western Canada last Decemb at Saskatoon. All those at the meeting we apparently agreed that there was a place f the proposed organization, but there w some uncertainty as to whether it should a separate society, affiliated with the C.S.T.A or a group within the C.S.T.A. An Organ zing Committee was finally appointed, wi instructions to proceed with the necessary d tails and to arrange for another meeting du ing the Royal Winter Fair at Toronto ne November, at which the new Society is e pected to be organized officially.

The Organizing Committee is as follow

President: Prof. Wade Toole,
Vice-President: Dean H. Barton,
Secretary: L. C. McOuat,
Directors: G. B. Rothwell, Experiment Farm, Ottawa, Ont.; S. E. Todd, Indu trial and Development Council of Cana ian Meat Packers, Toronto, Ont.

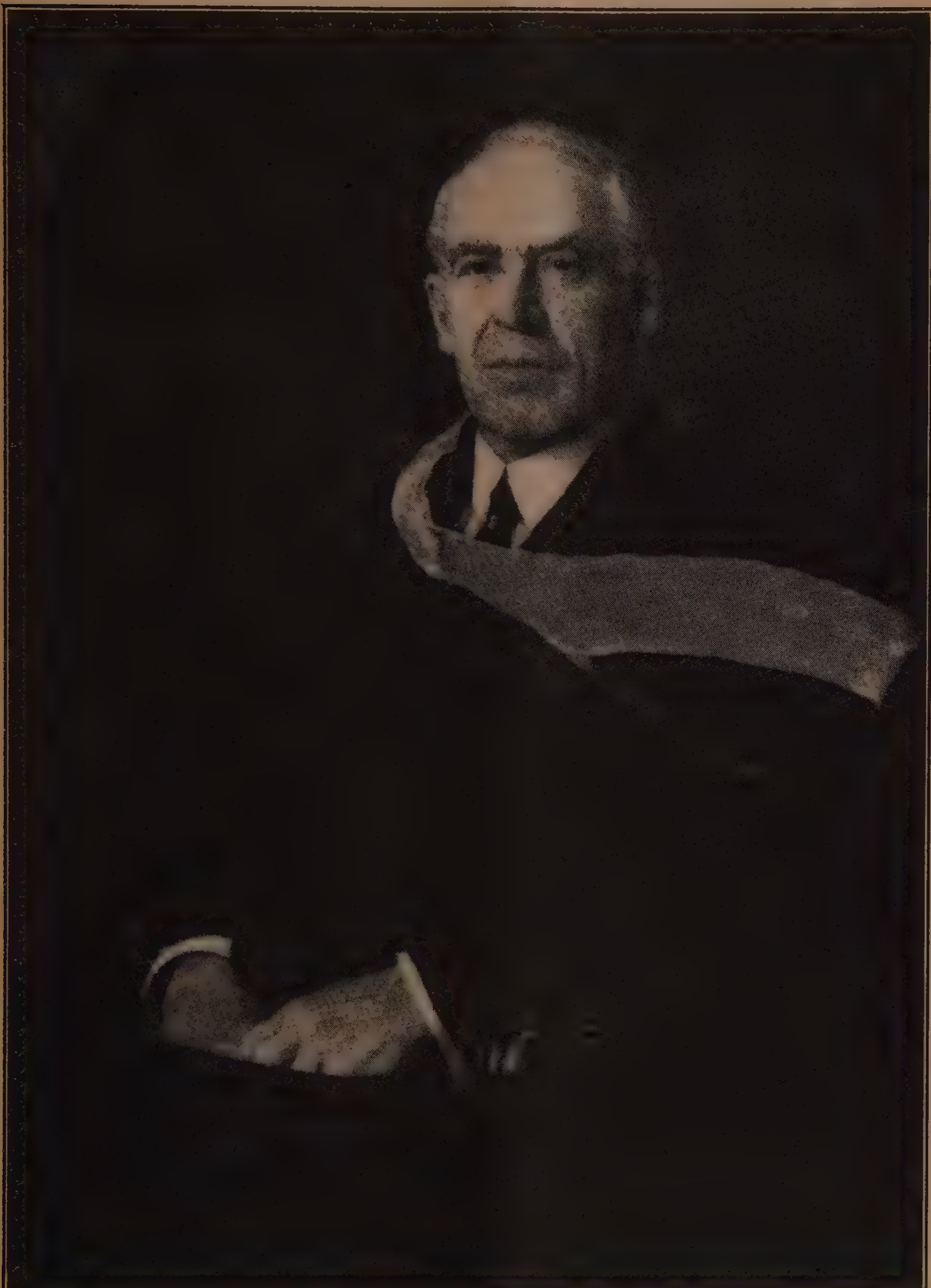
C.S.T.A. HORTICULTURAL COMMITTE

As a result of a meeting held at Ottaw during the C. S. T. A. Convention, it w decided to ask the authority of the C.S.T. Executive to form a Horticultural Commi tee within the Society, such Committee, group, to give special consideration to hort cultural matters of importance, to act in advisory capacity in relation to the Canadi Horticultural Council, to hold horticultur meetings during the C.S.T.A. Convention and generally to take care of horticultur interests.

Mr. W. T. Macoun, Dominion Hortic turist, was appointed chairman of the Co mittee, and Mr. A. J. Logsdail, Kemptvil Agricultural School, Secretary.

Further announcement concerning t C.S.T.A. Horticultural Committee and t Eastern Canada Society of Animal Produ tion will be made from time to time in the pages.

AWARDED 1926 C.S.T.A. FELLOWSHIP



WILLIAM LOCHHEAD, B.A., M.Sc.

(From the portrait by G. Horne Russell, P.R.C.A.)

CO-ORDINATION OF AGRICULTURAL POLICIES

Under the chairmanship of Dr. J. H. Grisdale, Deputy Minister of Agriculture for Canada, an informal discussion took place, on the afternoon of June 25th, on the question of "Co-ordination of Agricultural Policies in Canada". Dr. Grisdale outlined the work of the Dominion Department of Agriculture, showing the co-operation which is practiced with the Provincial Departments of Agriculture. In matters of enforcing Federal Acts in regard to the grading and marketing of agricultural products this work is clearly Dominion work, but even here the Provinces co-operate in many respects, and conversely in matters of production, which is considered as Provincial work, the Dominion Department helps out when requested to do so.

Dean E. A. Howes, Head of the Faculty of Agriculture of the University of Alberta, led in the discussion and pointed out that teaching is recognized as Provincial work, and investigation or research is necessary to effective teaching. There should be the closest co-operation with the Dominion Department which was engaged in research before the Agricultural Colleges were organized. Extension work so-called belongs legitimately to the Agricultural Colleges and this term should not be applied to work performed by the Departments of Agriculture. Provincial laboratories, staffs, and graduate students taking research work might be made use of by the Dominion Department during the summer months and given credit for the results obtained.

H. Barton, Dean of the Faculty of Agriculture, Macdonald College (McGill University) stated that practically all workers had the spirit of co-operation and that there really is not much to worry about. Present conditions compel co-operation because the facilities for work are limited in all Departments. Quebec was cited as an example of what could be done through a Provincial Seed Board bringing together officers of the Agricultural College and the Provincial and Dominion Departments for combined efforts to improve the field crops of the Province through the use of good seed of the best varieties.

Director E. S. Archibald of the Experimental Farms Branch suggested that a Committee be appointed to outline the various fields of work that should be performed by th different agencies.

Dean Clement, head of the Agricultur Faculty of the University of British Colu bia, explained that much of the criticism w not well founded. Policies should be form only after studying the literature and getti the views of all workers, both Dominion a Provincial. Conferences and consultatio are especially valuable to this end.

Mr. N. Savoie, Secretary of Agriculture f Quebec showed the harmony that existed b tween his Department and the Domini Department of Agriculture. Demonstrati work and the popularising of results obtai ed by Dominion Experiment Stations shou be Provincial work, in addition to teachi and some research.

Mr. W. B. Roadhouse, Deputy Minister Agriculture for Ontario, expressed appreci tion of the attention given to the affairs the Convention by Dr. Grisdale. He referr to the Agricultural Instruction Act havi provided the machinery of co-operation a the financial means of carrying it out, b this Act had gone out of existence as a ma ter of Government policy. The formation policies is a Government prerogative, but individuals and as a body we may have part in framing these policies. The C.S.T. deserves great credit for bringing the va ious officers together to discuss common pro lems and agree as to the best means of tacking them.

Mr. J. A. Clark, Superintendent of t Dominion Experimental Farm at Charlott town, Prince Edward Island, stated that t Province originally purchased the Farm a passed it over to the Dominion. He explai ed the wonderful co-operation displayed establishing Prince Edward Island as disease-free area for tuberculosis in cattl Dominion and Provincial officers always co sult before initiating any work and excelle results are obtained.

Dr. J. A. Ruddick, Dairy Commission outlined the demarcation of work as betwe his Branch and the Provincial Dairy Bra ches. Provincial officers have co-operat most heartily in the conducting of Dairy R search and contributed very materially to t obtaining of valuable results.

Report of the General Secretary.

Presented at the Sixth Annual Convention,
C.S.T.A., Ottawa, Ont., June 23, 1926

By FRED. H. GRINDLEY

I have the honour to submit the following report for the year ending May 31, 1926. It is interesting to reflect, at the outset, that the Society was organized in this hotel six years ago, and it is especially gratifying to know that it has returned safely, and very soundly, after a somewhat stormy career. Those of you who were members of the Society at the time of the Ottawa Convention in 1920, can make some interesting comparisons between the C.S.T.A., at that time and the organization as it is to-day. Your comparisons will reflect credit upon those who have served either as officers, executive members or committee members since that time. Progress has been steady, new activities have been undertaken each year, fees have been lowered, membership has more than doubled, local branches have been organized and a self-supporting official organ has been established. The result is that we now have many advantages, as an organization, which were mere visions six years ago. It is perhaps true that the Society has lost some members because its progress has not been more rapid and the results of its organization more spectacular, but I am inclined to think that real progress should come slowly and that new activities should be undertaken only when there is an apparent and wide-spread need for them.

Membership

During the past year the names of ninety-two members were taken from the membership list. Very few of these were resignations, most of the removals being for non-payment of fees. The figure is unusually large, but includes quite a number who were in arrears a year ago. In other words, the removal of delinquent members has been more strict than in former years, and probably the result will be beneficial in the end. It is to be expected that a number of these members will join the Societty again and pay their fees more promptly in the future.

I regret to record the loss of two members through death — Reverend Brother Liguori who died on August 31, 1925, and Mr. J. Ernest Pintal who died later in the year.

As a result of a rather extensive membership campaign in the last four months of 1925, applications were received from two hundred and fifteen new regular members, and forty-three student members. You will recollect that student membership was introduced only last year and the response has been very satisfactory indeed.

On May 31, 1926, the membership of the Society was eight hundred and sixty-eight regular members and forty-three student members, a total of nine hundred and eleven, as compared with seven hundred and forty-seven regular members a year ago. It is practically certain that the total membership will pass one thousand during the coming year. A complete list of resignations, applications etc., for the past year is appended to this report. Notable increases in membership are shown in Alberta, Manitoba, Ontario, Quebec and Saskatchewan. The only province which shows any serious decrease in membership is British Columbia and this is chiefly due to the transfer of members from that province to other parts of the Dominion.

The present distribution of membership by locals is as follows:—Alberta, 98; British Columbia, 59; Manitoba, 72; New Brunswick, 32; Nova Scotia, 28, Eastern Ontario, 114; North-western Ontario, 8; Western Ontario, 106; Niagara Peninsula, 25; Prince Edward Island, 10; Macdonald, 57; Montreal 72; Quebec, 58; Ste. Anne de la Pocatière, 44; North Saskatchewan, 49; South Saskatchewan, 51; British and Foreign, 28.

During the year three local branches were organized—one for North-western Ontario at Port Arthur, Ont., on June 16, 1925, one at Ste. Anne de la Pocatière, P.Q., on October 1, 1925 and one for the Niagara Peninsula at St. Catharines, Ont., on February 20, 1926. This brings the total number of local bran-

ches to sixteen. All these branches appear to be giving service to the members, to be holding meetings as often as is desirable and to be in fairly sound financial condition. It is unlikely that the number of branches will ever exceed twenty.

Affiliations

The Report of the Committee on Affiliations will record affiliation with the British Association for the Advancement of Science and the Agricultural Education Association in Great Britain. Affiliation with the Royal Society of Canada, the World Agriculture Society and the American Association for the Advancement of Science have been reported previously. There are now no further affiliations on the part of the C.S.T.A., immediately apparent and consideration should be given to the basis upon which the Society will accept other and smaller scientific bodies into affiliation with itself.

"Scientific Agriculture"

There is little to report in connection with the Society's official organ except that it has been published regularly and promptly each month during the year and that it has been maintained on a self-supporting basis.

The two common criticisms of our official organ, on the part of many members, are that it is too technical and that it devotes too little space to articles—even technical articles—dealing with animal husbandry, horticulture, and some other branches of agriculture. There is, of course, no fixed editorial policy and space is limited. So far as space will permit, the magazine will publish any suitable article received, either technical or popular, and will give preference to articles written by its own members. That statement answers most of the criticisms. Members should, however, realize that a great many British and foreign libraries and abstracting journals are subscribing to *Scientific Agriculture*, and that the magazine and the Society receive considerable recognition in this way. To popularize the magazine too much would undoubtedly result in the cancellation of some of these subscriptions.

It is unfortunate that the funds of the Society will not permit of a larger magazine, in which one section could be devoted to popular articles and one section to technical articles. At the present time, with only thirty-six pages of reading matter (eight of which are at the disposal of the French members) a division into two parts is not practicable. It is possible that the Society might obtain financial assistance from interested institutions for the publication of research material, in which case many of our difficulties would be solved.

The whole question of editorial policy is one to which serious consideration ought to be given by every member.

During the year an effort has been made to develop exchanges between *Scientific Agirculture* and other similar magazines, with the object of building up a useful reference library. I am glad to report that the following magazines are now being received free and may eventually be bound in annual volumes if funds will permit:—

Experiment Station Record,
American Journal of Botany,
Journal of Heredity,
Philippine Journal of Science,
Journal of Agricultural Research,
Annals of Missouri Botanical Garden,
Science,
Review of Applied Mycology,
Review of Applied Entomology,
Chemical Abstracts,
Philippine Agriculturist,
Contributions from Boyce-Thompson Institute for Plant Research,
Agricultural Progress,
Soil Science.

The number of exchanges is increasing steadily but there are of course several high priced scientific periodicals which will not enter into an exchange arrangement.

Bureau of Records and Employment

As a result of a resolution passed at the last annual Convention, an effort has been made to organize a Bureau of Records and Employment within the Society. It appeared an impossible undertaking at first because of the vast amount of clerical work and printing involved, the expense of which was quite beyond our resources. Just at the time when it seemed necessary to give up the idea altogether, the Chilean Nitrate Committee through its Canadian delegate, Mr. Leslie Emslie who is a keen C.S.T.A. member, made a generous donation of $1000.00 to cover organization expenses during the calendar year 1926. This money was not made available

ntil after the New Year, so that it has not een possible to carry the organization work s far as might have been hoped.

As a necessary first step in the develop-ent of the Bureau, a list of the members ith their titles and addresses, was publish-l in February. This was sent to every mem-er and given fairly generous distribution mong commercial firms which might be in-rested.

Following the publication of this list there as prepared and sent to each member a reliminary Announcement concerning the roposed Bureau. With this was enclosed n information card for the Records Section. hose desiring of registering in the Employ-ent Section were sent a registration card n request.

In order to ascertain the attitude of pos-ble employers to the Bureau, a leaflet was lso prepared and sent, with a covering letter, a fairly representative list.

All of this preliminary, or organization ork, was completed between February and lay, and a general statement of results will e made to a special committee at this Con-ention. This Committee should then be repared to recommend either that the Bur-au be discontinued or, if not, the policies nder which it should be operated.

Text Book Club

Sales of agricultural books have far ex-eeded those of any previous year. This ctivity is plainly gaining in popularity, and lthough it produces no profit for the Soc-ty, it is a distinct membership service. The ork involved is now practically all of a outine nature, occupying very little time.

Travelling

During the year the General Secretary was ble to visit the local branches in North-estern Ontario, Manitoba, and North and outh Saskatchewan en route to the Edmon-on Convention. The Convention brought im in contact with most of the members in lberta. He has visited the branches of Vestern Ontario, Niagara Peninsula, Eastern ntario, Macdonald, Montreal, Ste. Anne de Pocatière and New Brunswick, in eastern anada, on one or more occasions. He has ever yet, since the fall of 1920, found time attend a meeting of members in British olumbia.

Considerable travelling has been necessary in Ontario and Quebec in connection with advertising.

Finances

An examination of the Financial Statement is particularly encouraging*. During the year an effort was made to adjust all annual fees so that they would fall due on a uniform date (June 1st) in each year. This meant that a great many members who have always paid \$6.00 to extend their membership for twelve months, paid only a sufficient fraction of that amount last year to extend their membership to June, 1926. Our revenue from fees was seriously reduced on that account.

There have been no large increases in any items of expenditure as compared with the previous year. Slight increases have been necessary for postage, telephone and cuts for illustrations, but against these, savings have been made in printing and stenography. The chief reasons for our financial improvement, however, are a gain in advertising revenue and a large increase in membership.

We come again to the question of fees. There is a pronounced feeling, fairly general throughout the membership body, that the annual fee should be reduced from \$6.00 to \$5.00. This would result in much simpler fee payments for regular members, namely an initiation fee of \$5.00 (except for new graduates) and an annual fee of \$5.00, and would remove the awkward odd dollar in the annual fee. On that basis I am prepared to recommend the reduction. It must be borne in mind, however, that our normal annual revenue is bound to be reduced by over \$900.00, and unless this loss is likely to be balanced by a growth in membership and a decrease in the number of resignations, the reduction is dangerous to our financial stability. We are more and more placing a heavy responsibility upon the magazine, and advertising revenue is rather thin ice at any time. Members are now paying less than half the total cost of operating the Society and publishing the magazine and apparently it is the desire of the majority that this ratio should be widened further.

* A printed copy of the Annual Financial Statement will be mailed free, on request, to any C.S.T.A. member.

While on the subject of finances, I should like to say that I believe more assistance should be given to the local branches. All of them could make good use of more money in stimulating membership interest and some locals are finding it extremely difficult to operate successfully on their present revenue of $1.00 per member. Since all locals are not in the same condition perhaps the Dominion Executive could assume the responsibility of deciding when and to what extent local branches should be assisted by the parent Society.

Standing Committees

Reports of all Standing Committees are being presented at this Convention.

The Sixth Annual Convention

Plans for the Convention which is now opening were started early in the calendar year. The thanks of the members are due particularly to Messrs. L. H. Newman, L. C. McOuat, F. C. Nunnick and E. T. Chesley, and also to the members of their Committees who have so ably attended to the work in connection with the programme, entertainment, reception and publicity. Grateful acknowledgment is also due to the Dominion Department of Agriculture, the Ontario Department of Agriculture, the Central Experimental Farm, the Kemptville Agricultural School and the Kiwanis Club of Ottawa for complimentary luncheons or banquets to the members. Particular mention should be made of the assistance given by the Dominion Department of Agriculture in making possible the series of advanced lectures included in the programme.

New Officers

Ballots for the annual election of officers were mailed to all members on April 10, 1926, and were opened at Ottawa on Ap 30th. The following official results were a nounced to the Canadian Associated Pre and published in the May issue of *Scienti Agriculture* :— President, G. C. Creelma Vice-preseidents, H. S. Arkell and L. P. Ro Honorary Secretary, L. H. Newman. S hundred and sixteen members voted.

Meetings of the Dominion Executive Co mittee were held at the University of Albe on June 26th, 1925, and at the Chateau Lau ier, Ottawa, on June 23rd, 1926.

The Society was officially represented the Annual Meeting of the American A sociation for the Advancement of Science Mr. Arthur Gibson and at the Annual Me ing of the Royal Society of Canada by t General Secretary.

In conclusion I wish to acknowledge t splendid assistance and co-operation I ha received throughout the year from the Pre dent and members of the Dominion Exec tive, the various local secretaries, membe of the Editorial Board and numerous co mittees, and finally, and even more especi ly, to Professor H. M. Nagant, our Fren Secretary and Editor who has done so mu to increase membership in the French s tions of Quebec and to improve the Fren pages of the magazine.

This has been a wonderful year in ma respects. No member can be pessimistic w any degree of justice. We can mark t Convention as our first stepping stone a we can start out again from Ottawa unc vastly more favourable circumstances th in 1920. I don't know when we shall m here again, but I do know that the C.S.T is firmly established and that its future acti ties and usefulness lie, more than ever, the hands of the membership body.

Presidential Address.

By E. A. HOWES

Dean of the Faculty of Agriculture, University of Alberta, Edmonton.

At the outset I would like to express my very sincere gratification at the honour done me in my election as President of the C.S.T.A. It is a distinction much to be prized at the time it is won, and sure to be the source of kindly feeling as the years go by. I assume that the distinction came my way because of certain small work, spasmodic, but none the less sincere, which I had the opportunity to perform in the West in the early days of the life of our Society. It seems only yesterday that I received notice of the informal gathering at Ottawa, I think, at which meeting it was decided that I should be asked to undertake the work of organization in the three prairie provinces for this young and ambitious Society of technical men in agriculture. I can afford to look back now at my somewhat ill-directed efforts with a certain grim amusement. A man whom I met on the trip, and who if he is not listening to me, is almost within reach of my voice, said that he had known me for a good many years, that he always had given me credit for at least a minimum amount of horse-sense, but this last move of mine had given him doubt. However, all is well that ends well, and it would be an unusual modesty that would prevent one from being gratified and proud to have had at least some small share in the building up of the great organization which is now holding its sixth convention.

As retiring President I should like to leave something of a constructive nature in my farewell address, but it is not always easy to select what is most fitting and what has not been said, and perhaps better said, by some other member of the society. There is one thing I would like to have recorded here, lest I forget to say it later, and that is that after the past year's experience I am more than ever confirmed in the belief which I had held for some time, that the President of any organization, such as ours, is lucky if he can figure as an ornament, because his direct usefulness, outside of that of being decorative, is in inverse ratio to the degree to which he interferes in the business of the Society. With all due respect to the President, I would like to submit that the Secretary of one organization I know is the "man behind", the man who makes the wheels go round, even the wheels in the heads of some of us.

I would like to take advantage of this opportunity to go on record by expressing deep appreciation of the valuable service done this Society in the securing of special lecturers for our annual meetings. It is a good thing for all of us, not only to come in touch with the latest scientific news, but incidentally to get an incentive towards a wider viewpoint, since we are always in danger of falling into a rut. I would like as retiring President to say to the Minister of Agriculture, through his Deputy Minister, Dr. Grisdale, that he has given most valuable assistance to the Society; also I wish him to realize that this assistance is very much appreciated.

One question I would wish to treat with in passing is that of membership. We started with an encouraging membership and this has grown until now it has reached proportions which would have seemed to us, in the early days, to be impossible. The growth has been very gratifying during the last year, due no doubt to the concentrated drive for members. I believe in the rounding up, if you will permit the Western term, of our final year students in our Colleges of Agriculture. It should not be a difficult thing to enlist their interest and sympathy in the work of our Society and thus secure their permanent membership. Speaking from the experience in our own institution, I may say that we have been very much pleased indeed with this addition to our numbers, and the graduating students themselves are strong in their expression of satisfaction of being privileged to sit in at our meetings, to get a first hand contact with the spirit that pervades the C.S.T.A., and to form a conception of the high ideals of our Society. I know I shall not be misunderstood as to motive when I earnestly exhort our members who are on College staffs to use their influence to line

up the boys who are to graduate, and get them started with the right idea towards our Society. I would conclude this exhortation by a homely hint that the good received will not be all on one side. A closer contact with the younger and coming ideals may sometimes perchance be good for what ails us.

I have planned to discuss, as retiring President, a problem which I and no doubt others, have thought over for some time; a problem which it is not just easy to put into words, and for this reason I must claim your indulgence if the ideas be somewhat crudely presented. The problem I would like to discuss is our personal estimation of our own profession and our manner in implementing the same. To state it in another way—what do we think of our status as technical agriculturists, as such, and as related to other professions, and next what are we doing to consolidate this status if we are satisfied, or to improve it if we are not satisfied? Now I am going to make some very serious statements, and all of them will not suit everybody, but I wish to be included among those to whom I am offering advice: I do not wish to be classed as the physician who will not take his own medicine. With this proviso let us get at the problem.

I think I may say at the start that very few of us are wholly satisfied with the standing of our profession: with the recognition it receives, not in dollars and cents alone, but in a comparative sense with other professions. I think I can state from hearsay alone that a fairly large number of our members feel that technical agriculture is not recognized as it should be. Very well, the next logical step would seem to be an inquiry into the cause, and also in passing an inquiry as to whether or not some of us may be suffering from an inferiority complex. This latter is largely a personal thing, and one which we cannot discuss here, except to say that an inferiority complex is a regretable condition and one against which we must fight to the uttermost. The first obvious question is, wherein lies the fault, or the deficiency, or the lack, however you may term it, and how may this be controlled? I am going to attack the question by being somewhat dogmatic in stating that if there is fair reason to suppose that we are not getting all that is coming to us, it would be well for us to remember that there are other things besides charity that begin at home. I can imagine conditions where it would be perfectly justifiable for one to carry a chip on his shoulder, figuratively speaking, and as an individual, or with his co-workers, to take a dignified stand as justified by the facts. In the main, however, it will be found safer in the long run to do our own house-cleaning first, before we pay much attention to the neighbours.

In the past one reason why agriculturists were not recognized as on a par with other professions was due in a large part to the fact that our technical education was not based upon a broad general preliminary training such as other professions demanded. Our Colleges took students who wanted to go on for a degree yet who lacked the foundational education to which I have referred. I do not mean that they were necessarily bad spellers and bad writers, because this failing is sometimes the attribute of genius, but they lacked the cultural and mental training which would necessarily come through the completion of public and high school experience. Of course there was an explanation of this, because at the outset our Colleges were confessedly intended to teach the direct vocation of farming. We have gone a long way along the road in the development of this work, but we still try to cover, with our one Bachelor's Degree, the man who is going back on the farm, the man who is going to be an agricultural advisor, the man who is going to teach, and the man who has a definite flair for research. I do not think that any other profession would attempt what seems to me to be just about the impossible. This is of concern because it is in a sense the reason why other professions in some cases present a more logical and consolidated scheme of service to the people of our country. I trust that our discussion on educational policies, when the Colleges of Agriculture come under fire, may result in a wholesome review of the whole question of our degree work.

The next point I would like to make is a somewhat daring one, but I must go on record as saying that I do not think agriculturists enhance their status by a prevailing penchant for publicity of a superficial order. Perhaps you know that it was an agricultural writer who was first called a "hack-writer" and his prepotency is scarcely sub-

ject to question. This man was haled to London and forced to sign the following declaration:

> "I, Gervase Markham, of London, gent., do hereby promise hereafter never to write any more book or bookes to be printed of the diseases of any cattle, horses, ox, or cow, sheep, swine or goats. In witness whereof I have hereunto set my hand the 24th daie of July, 1617. Gervase Markham."

The writer of the first Scottish treatise on agriculture admitted quite naively that he had made a failure of farming and was now going to write about things agricultural because he had been told that there was good money in it. We can never be able to achieve 100 per cent. dignity in the matter of publicity, but I do think that our Society can be a wonderful influence in restraining this sort of thing to reasonable bounds. We can build up a tradition to the effect that "this sort of thing isn't done". It is a grim fact that many of our best services in agriculture have been acompanied and preceded by a verbal chinook, written and spoken. It is also a grim fact that often the value of some of our research work is bankrupted by advance notices. It is a matter of history that the common use of such important crops as clover and turnips in England was impeded almost to the extent of half a century by the disrespect into which technical agriculturists of that day had fallen because of their exaggerated statements in regard to these and other crops. Lord Ernle in speaking of this period of the early dawn of agricultural science remarks about the agricultural men of that day:

> "Their promises were often exaggerated beyond the bounds of belief; mixed with some useful suggestions were others which were either ridiculous or of doubtful value. Men actually and practically engaged in cultivating the soil were, therefore, justified in some distrust of book-farmers. Turnips were undoubtedly an invaluable addition to agricultural resources. But it was an exaggeration to say with Adolphus Speed that they were the only food for cattle, swine, and poultry, sovereign for conditioning "hunting dogs", an admirable ingredient for bread, affording "Two good crops" each year, supplying "very good syder" and "exceeding good oyl".

I do not mean to say that our profession has a monopoly on this sort of thing, but I do ask you how certain performances that must have come to your notice, would have been challenged in any other technical profession. It is true that as a Society we can only advise; we are not working with disciplinary powers. That day may come, and despite our various interests I am none too sure that it would be altogether a bad thing. As one who is older than most of you, and cannot possibly have an axe to grind, I wish to exhort every member of our Society to think seriously of the dignity of his profession and of the building up of a tradition; not only upon whatsoever things are true, but also upon whatsoever things are fitting. Now of course this cap does not fit any of us who are here, but most of us know somebody it would fit.

One reason perhaps why our profession may suffer question as to status is, I firmly believe, due to the fact that our ideals and practices are not based on definite foundations. There is no other profession that pays so little attention to the history of those who have gone before, and to the history of the achievements of other days, and pays practically no attention to the ideals of the agriculturists whom we follow. For example, I cannot conceive that there was any inferiority complex as regards agriculture in Greece even in the days of her military glory. I cannot think so when one of her greatest Generals, who was at the same time a lawgiver, an economist and a farmer, has handed to us down through the centuries his belief, "that agriculture is the most fitting employment for men of honorable birth", and yet today he figures in our histories as a military man and as a law interpreter rather than as an agriculturist. I cannot think that agriculture suffered from an inferiority complex in Rome, "in the brave days of old", when I find that one of her most distinguished senators who, by the way was also a distinguished economist, and also a farmer, gave as his confession of faith:

> "It is from the tillers of the soil that spring the best citizens, the staunchest soldiers; and theirs are the enduring rewards which are most grateful and least envied.

Such as devote themselves to that pursuit
are least of all men given to evil counsels".
Yet he is handed down to us in three histories, I investigated lately, as a successful warrior and an outstanding statesman: no mention is made of his wonderful influence in agriculture. But why blame the historians? They write about things they think would most attract our interest. I wonder how many think of Virgil as other than one of the pets of the exponents of a dead language, and yet this great poet's greatest inspiration came from his interest in things agricultural. I am not holding out the hope that our technical agriculturists may develop into great poets, although that might be another avenue for publicity, but I would seriously call your attention to the fact that this farmer Virgil who followed "on the heel of long and desolating wars", is given sometimes the credit of having, from an economic standpoint, saved the nation, because he saved its soul. These agriculturists did not suffer from an inferiority complex. The point I wish to drive home is that a study of the achievements of the best agriculturists of the past, a study of their ideals, will beget in us a becoming pride in our profession; a pride which must be reflected in the attitude of others toward us. A similar study would also beget in us a becoming modesty because the best this generation can hope to achieve in technical agriculture is, in terms of the race, but small. The most any of us can do is to leave things a little better for those who follow. We must not get into the frame of mind that all wisdom begins and ends with us. I know this is an extreme statement but I think the point at times has application. I mentioned at Guelph two years ago a certain case. I had elsewhere been listening to a man talking on the rust problem, a very vital problem indeed, and I had no reason to take exception to practically all that he said; indeed some of it I confess was over my head but probably none the less true. However, the whole effect was spoiled when he said "we have discovered that the presence of barberry is conducive to the spread of rust, and we would advise farmers....". It happened that just a few days before I had chanced upon a paragraph in The Beginnings of Agriculture in America, in which I found that there had been legislation introduced back in 1726 in Connecticut for the eradication of Barberry bushes, and the preamble read:

"Whereas the abounding of barberry bushes is thought to be very hurtful, it being by plentiful experience found that, where they are in large quantities, they do occasion, or at least increase, the blast on all sorts of English grain".

I do not mean that the speaker was like Hetty Poyser's rooster that thought the sun got up to hear him crow, but I do feel that he was not suffering from an overwhelming modesty when it came to claiming credit. Another example is to be found in our irrigation projects, because the best we have been able to do so far in reclamation is comparatively small when compared to those carried on successfully by a race that long has passed away. I refer to the supposed progenitors of the Incas of Peru. Now some of you will say that one who lacks in modesty is perhaps not suffering from the inferiority complex, but I do submit that this sort gives some of the rest of us cause to suffer for the profession. Again agriculture has no monopoly on this type, but again I state let us do our own house-cleaning first.

Another suggestion that I have to make is scarcely as pertinent as it would have been 25 years ago; it is to the effect that technical agriculture is, to use a somewhat whimsical phrase, built from the top down. In the past almost in the whole, and in the present in part, technical agriculture has not paid attention to its foundation. I mean elementary agriculture. Some of us are old enough to remember lacrosse in the heydey of its prosperity. I was well acquainted with one burning enthusiast at least, and because he was an enthusiast he has watched the decline of this grand game as the years went by, and he has come to the conclusion that the decline began when lacrosse was superseded by other games in the public schools. The stars in lacrosse went the way of the flesh, and ere long a time came when there was one to step in to fill the ranks, and for years they have gone on trying to build from the top down. In a measure this has been true of agriculture. The bright minds among our own people have been trained in public and high schools where the goal indicated was the profession of the doctor, lawyer, merchant, anything but an agriculturist, and yet it is today as it has ever been a sound physiologi-

l principle that the influences that act on e mind of the child are of paramount im- ortance. How much are we doing to foster griculture in our public and high schools? the first article I ever wrote on agricul- ıral education I said "It is not the sum total agricultural facts taught that counts, it is e bent of mind induced in the pupil. Train m to think with interest in, and respect for, e profession that is his father's and his other's, and when he is older he will not epart from it, even though he does not ork at it". I have not changed my mind ne particle as to the soundness of the fore- oing, although I wrote it back in 1905, and hat is true as a principle in regard to our ublic schools is doubly true as regards our igh schools, because from these and the ıcceeding normal schools come the teach- s who train our children, and who get eir first experience in rural districts. A oy who comes up through a public school nd a high school that recognize agricul- re, not only on their curricula, but in spirit, nd who later goes to a College of Agricul- re and enters service in some kind of agri- lture, is bound to be an asset in building the status of our profession, much more than if he went to an agricultural college st because they did not know just what do with him at home, or if he went to the ollege because someone had just lately sold m the idea that there was good money in . No matter what variation there may be the personal opinion of each one, he should el an interest in helping to lay this founda- onal work in technical agriculture. That as the reason why I paid so pointed a com- iment to the work of the agricultural agent, my talk at Toronto last fall. His work with the younger people is a grand piece of home missionary effort.

Perhaps some of you expected me to launch out into an eulogy in regard to research work, as a means of raising the status of our profession. I scarcely felt that this was necessary, particularly when so many of you know the extent to which our little College of Agriculture has gone in developing this important phase of agricultural effort. Instead I would rather issue one little word of warning that will be pertinent in days to come, I feel sure. Let us be careful in our Colleges that we do not get to the point of building from the top down in our courses of study; let us not neglect the men in the Freshmen and Sophomore years because of our natural interest in the specific work of a few advanced star pupils.

The foregoing and sedate words of wisdom are offered because it would seem that our Society should be the clearing-house of the problems that are general to technical agriculture, and should in a sense become the custodian of our honour, dignity, and idealism of technical agriculture. Unless you grant the truth of this my suggestions to you as retiring President are mere presumption, but if you grant the truth of this then you are bound to take up these ideas and ponder them carefully. I do not hold that you should all agree with me; it is not well that such should be so, and I confess to a temptation to make some of my statements provocative in the best sense. My kindly interest will not be questioned I trust, and in any case some of the ideas were born of a personal heart searching within the past few years; in how far it resulted in personal benefit is another question.

Report of the Committee on Educational Policies*

Your Committee beg to present the following report and recommendations:

The recommendations herewith submitted are based on the report which was presented at the Edmonton convention, on the proposed amendments which were made at that time, and on suggestions which have been received during the past year. These have been carefully considered by the committee and a number of them have been embodied in the report.

The recommendations of the main committee on educational policies in agricultural colleges are submitted first. These will be followed by the conclusions of the sub-committee on educational policies in agricultural schools, and these, in turn, by the recommendations of the sub-committee on educational policies in public and high schools.

The sub-committee on educational policies in agricultural schools has not been able to meet during the year; but as all available data have been collected and published, it is hoped that the conclusion, which has been prepared by the chairman, will meet with general approval.

PART I

Recommendations
Agricultural Colleges

1. *Re the Relation of the Colleges to the Provincial Departments of Agriculture.*
   That agricultural colleges be constituted independent of Departments of Agriculture.
2. *Re the Relation of the Colleges to the Lieutenant Governor in Council.*
   That colleges and faculties of agriculture be made directly responsible, through their governing bodies, to the Lieutenant Governor in Council.
3. *Re the Relation of the Colleges to the Universities.*
   That agricultural colleges and faculties of agriculture sustain the same relationship to their respective universities as that sustained by other colleges or faculties.
4. *Re Associate Courses.*
   That the associate course, when offered, be separate and distinct in curriculu and instruction from the degree course.
5. *Re Matriculation Standards for Degre Courses.*
   That the requirements for admission t the faculty of agriculture be equivalen to, and interchangeable with, the require ments for admission to the faculty of arts
6. *Re Undergraduate Courses.*
   (a) That the greater part of the firs and second years of the undergraduat course be devoted to the sciences and t the humanities.
   (b) That the greater part of the two fina years of the undergraduate course be de voted to the applications of science to th practice of agriculture.
   (c) That the principle of electives b adopted for the two final years of th undergraduate course.
   (d) That specialization be reserved fo graduate study.
7. *Re Graduate Courses.*
   That in view of the higher standards o professional training now demanded o graduates in agriculture, better oppo tunities and facilities be provided fo graduate work in Canada.

PART II

Conclusions
Agricultural Schools

After making a careful study of the ma ority of agricultural schools in Canada, yo committee are convinced that the usefulne of these schools is undoubted. Neverthele it is extremely difficult to make recommend tions regarding them. Parts I and III the report deal with relatively clearly d fined divisions of educational endeavor which a fairly unified policy, extending ov a long period of years, has resulted in t accumulation of much information, and t making available of a body of experience educational matters which is of great a sistance to a committee in reaching a de

* Adopted at the Sixth Annual Convention of t Canadian Society of Technical Agriculturists Ottawa, June 23rd, 1926.

sion. In the case of the agricultural schools, on the other hand, the situation is very different. They are small in number and of recent origin, the conditions under which they are conducted differ widely, and as might be expected, the results obtained fluctuate appreciably. These factors make it inadvisable, if not well nigh impossible, to draft a set of recommendations based upon, and confined to, the experiences of agricultural schools in Canada. Your sub-committee are of opinion that these schools have a unique opportunity to become the centres of vocational education in agriculture, and if they will confine their attention to this undeveloped field their future would appear to be assured.

Signed—L. S. Klinck, Chairman.
H. A. Craig.
W. J. Bell.
A. T. Charron.

PART III

Recommendations

Public and High Schools

A. Public Schools

1. *Re Qualifications and Preparation of Teachers.*

(a) That general science and agriculture be made compulsory as part of the academic training of all prospective teachers of rural schools.

(b) That teachers' training courses in elementary agriculture and related sciences be established in all normal schools and that supplementary courses for teachers in provincial summer schools be adequately supported.

2. *Re Status of Agriculture in the Public School Curriculum.*

That the teaching of elementary agriculture in the higher grades be made compulsory in rural schools following upon suitable courses in general nature study in the lower grades.

3. *Re Method of Teaching.*

That some form of practical work be required as an essential part of the course in elementary agriculture.

4. *Re Organization and Management.*

That all instruction in public and high schools be under the direction and control of Provincial Departments of Education.

5. *Re Organization and Scope of School Fairs or Exhibitions.*

(a) That school fairs or exhibitions be organized primarily for educational purposes and be so conducted as to represent achievement in all lines of school and allied home activities.

(b) That school fairs or exhibitions be held under the general direction of Provincial Departments of Education.

6. *Re Organization and Management of Boys' and Girls' Clubs.*

(a) That "Clubs", as referred to in this section, include as members boys and girls from ten to sixteen years of age.

(b) That all projects conducted in connection with boys' and girls' clubs be definitely related to the teaching of elementary agriculture, manual training and home economics in the schools.

(c) That home projects and club organization be under the general direction of Provincial Departments of Education.

(d) That junior farmers' and young women's Clubs, for young men and women over sixteen years of age, be organized under the general direction of extension departments in colleges and universities, where such exist, otherwise, under Provincial Departments of Agriculture.

B. High Schools

1. *Re the Teaching of Agriculture in High Schools.*

(a) That agriculture be accorded equal rank and credit with other high school science subjects.

(b) That high school courses in agriculture occupy not less than two years of regular instruction with a minium of four periods per week.

(c) That courses offered in science and agriculture be made concrete through the use of laboratory and demonstration gardens supplemented by agricultural home projects.

(d) That Provincial Departments of Education be urged to recognize the import-

ance of this method of instruction by giving adequate financial aid to school boards toward meeting the cost.

2. *Re Qualifications and Preparation of High School Instructors in Agriculture.*

(a) That the teaching of agriculture in high schools be carried on by agricultural graduates.

(b) That agricultural college graduates be eligible to obtain professional standing as high school teachers on the same terms as graduates in the faculty of arts and science, namely, one year in a normal training college or faculty of education.

(c) That agricultural graduates who, previous to July first, 1926, have been employed as teachers of agriculture in secondary schools, and who have completed a full normal school course, be granted professional standing as teachers in secondary schools.

(d) That on the approval of the Department of Education, agricultural graduates who have not had normal training, but who, prior to July first, 1926, have been employed as teachers of agriculture in secondary schools, be permitted to obtain professional standing on the completion of at least two approved summer courses in education.

Signed—J. W. Gibson (Chairman)
F. W. Bates
J. B. Dandeno
L. A. DeWolfe

Your Committee strongly recommends that steps be taken by this convention, through the appointment of a small committee, or otherwise, to ensure that such recommendations as are approved by this convention, be brought to the attention of the Department of Education and the Department of Agriculture in each of the provinces, to the Dominion Department of Agriculture, and to the agricultural colleges and faculties of agriculture in Canada.

Signed—
L. S. Klinck (Chairman)
H. S. Arkell
H. A. Craig
M. Cumming
C. Gagné
F. C. Harrison
E. A. Howes
W. C. McKillican
Rev. Father Leopold
J. B. Reynolds
W. J. Rutherford

Editor's Note: Immediately after the Ottawa Convention, Dr. L. S. Klinck, Chairman of the C.S.T.A. Committee on Educational Policies, was appointed by the Dominion Executive Committee as a Special Committee to visit the various Universities of Canada, and to endeavour to have the foregoing recommendations put into effect. As we go to press we are in receipt of a message from Dr. Klinck to the effect that he has completed his visit to the Universities in Eastern Canada and that his report, as adopted at the Ottawa Convention, has been received with gratifying favour. Dr. Klinck is now visiting the Western Universities en route to British Columbia. —F.H.G.

Convention Attendance.

The following list gives the names and addresses of all members who signed the official register during the Convention:—

R. H. Abraham, Chatham, Ont.; E. S. Archibald, Ottawa, Ont.; G. G. Archibald, Ste. Anne de Bellevue, P.Q.

C. F. Bailey, Fredericton, N.B.; J. P. S. Ballantyne, Kapuskasing, Ont.; S. C. Barry, Ottawa, Ont.; A. F. Barss, Vancouver, B.C.; H. Barton, Macdonald College, P.Q.; W. J. Bell, Kemptville, Ont.; E. Biggar, Mount Pleasant, Ont.; A. H. W. Birch, Ottawa, Ont.; W. S. Blair, Kentville, N.S.; J. E. Blakeman, Winnipeg, Man.; S. F. Boily, Sherbrooke, P.Q.; G. Bouchard, Ste. Anne de la Pocatière, P.Q.; F. W. Brodrick, Winnipeg, Man.; F. E. Buck, Vancouver, B.C.; E. N. Buckley, Smiths Falls, Ont.; T. G. Bunting, Macdonald College, P.Q.; L. F. Burrows, Ottawa, Ont.

M. Champlin, Saskatoon, Sask.; L. T. Chapman, Lacombe, Alta.; R. P. Charbonneau, Montreal, P.Q.; A. T. Charron, Ottawa, Ont.; E. T. Chesley, Ottawa, Ont.; J. A. Clark, Charlottetown, P.E.I.; F. M. Clement, Vancouver, B.C.; R. L. Conklin, Macdonald College, P.Q.; P. R. Cowan, Ottawa, Ont.; E. W. Crampton, Macdonald College, P.Q.; H. G. Crawford, Ottawa, Ont.; G. C. Creelman, Beamsville, Ont.; J. M. Creelman, Beamsville, Ont.

P. M. Daly, Ottawa, Ont.; J. G. Davidson, Toronto, Ont.; M. B. Davis, Ottawa, Ont.; J. A. Dawson, Ottawa, Ont.; J. W. Delaney, Hull, P.Q.; S. M. Denison, Ottawa, Ont.; A.

DOMINION EXECUTIVE COMMITTEE, C.S.T.A. 1926-27.

Sitting (left to right)—E. A. Lods (Macdonald); Fred. H. Grindley, General Secretary; E. A. Howes, Retiring President; G. C. Creelman, President-elect; L. P. Roy, Vice-President; B. L. Emslie (W. Ontario).

Standing—A. R. Milne (Niagara Peninsula); W. C. McKillican (Manitoba); G. R. Wilson (New Brunswick); J. W. Gibson (British Columbia); L. E. Kirk (North Saskatchewan); R. P. Charbonneau (Ste. Anne de la Pocatière); H. M. Nagant (Montreal).

H. S. Arkell, Vice-president, L. H. Newman, Honorary Secretary, and the representatives from Alberta (J. P. Sackville); Nova Scotia (Arthur Kelsall); Eastern Ontario (P. Stewart); Prince Edward Island (B. F. Tinney); Quebec (Omer Caron), and South Saskatchewan (G. A. Ewart), are not in the photograph.

SIXTH ANNUAL CONVENTION,

Desautels, Quebec, P.Q.; B. T. Dickson, Macdonald College, P.Q.; F. Dimmock, Harrow, Ont.; J. Dougall, Ste. Anne de Bellevue, P.Q.; F. L. Drayton, Ottawa, Ont.; R. S. Duncan, Toronto, Ont.; W. G. Dunsmore, Ottawa, Ont.

G. A. Elliott, Ottawa, Ont.; R. M. Elliott, Ottawa, Ont.; B. L. Emslie, Toronto, Ont.

H. J. M. Fiske, Ottawa, Ont.; J. Fixter, Ottawa, Ont.; F. Forsyth, Perth, Ont.; P. Fortier, La Ferme, P.Q.; F. Foulds, Winnipeg, Man.; G. S. Fraser, Ottawa, Ont.; J. F. Fraser, Kemptville, Ont.; J. G. C. Fraser, Ottawa, Ont.; J. C. Fuller, Toronto, Ont.; A. Fulton, Ottawa, Ont.

J. W. Gibson, Victoria, B.C.; C. B. Gooderham, Ottawa, Ont.; C. H. Goulden, Winnipeg, Man.; H. W. Graham, Britannia Bay, Ont.; J. W. Graham, Ottawa, Ont.; F. H. Grindley, Ottawa, Ont.; J. H. Grisdale, Ottawa, Ont.; H. Groh, Ottawa, Ont.

G. C. Halliday, Sawyerville, P.Q.; R. S. Hamer, Ottawa, Ont.; L. H. Hamilton, Macdonald College, P.Q.; R. I. Hamilton, Ottawa, Ont.; T. D. C. Hamilton, Ottawa, Ont.; E. K. Hampson, Kemptville, Ont.; J. B. Harrington, Saskatoon, Sask.; F. C. Hart, Toronto, Ont.; L. G. Heimpel, Macdonald College, P.Q.; C. H. Hodge, Montreal, P.Q.; E. G. Hood, Ottawa, Ont.; G. B. Hood, Toronto, Ont.; E. A. Howes, Edmonton, Alta.; C. B. Hutchings, Ottawa, Ont.; F. B. Hutt, Winnipeg, Man.

J. T. Janson, Ottawa, Ont.; A. R. Jones, St. John, N.B.; W. M. Jones, Ottawa, Ont.

J. K. King, Moncton, N.B.; L. E. Kirk, Saskatoon, Sask.; L. S. Klinck, Vancouver, B.C.

F. Larose, Plantagenet, Ont.; J. E. Lattimer, Madison, Wis.; J. Laughland, Napanee, Ont.; R. L'Ecuyer, Ottawa, Ont.; W. W. Lee, St. Agathe des Monts, P.Q.; G. Le Lacheur, Ottawa, Ont.; O. A. Lemieux, Ottawa, Ont.; Father Leopold, Oka, P.Q.; P. E. Light, Ottawa, Ont.; A. G. Lochhead, Ottawa, Ont.; E. A. Lods, Macdonald College, P.Q.; A. J. Logsdail, Kemptville, Ont.

W. T. Macoun, Ottawa, Ont.; J. C. Magnan, St. Casimir, P.Q.; T. G. Major, Ottawa, Ont.; A. W. Mason, Guelph, Ont.; T. H. Mason, Ottawa, Ont.; W. A. Maw, Macdonald College, P.Q.; C. M. Meek, Carp, Ont.; A. R. Milne, St. Catharines, Ont.; G. G. Moe, Vancouver, B.C.; J. E. Montreuil, Farnham, P.Q.; J. C. Moynan, Highland Park, Ont.; G. W. Muir, Ottawa, Ont.; J. B. MacCurry, Ottawa, Ont.; W. G. MacDougall, Lennoxville, P.Q.; A. E. MacLaurin, Ottawa, Ont.; A. A. MacMillan, Ottawa, Ont.; H. Mac-

OTTAWA, ONT., JUNE 23-26, 1926.*

Pherson, Antigonish, N.S.; C. M. MacRae, Ottawa, Ont.; A. P. MacVannel, Picton, Ont.; E. D. McGreer, Kingston, Ont.; W. G. McGregor, Ottawa, Ont.; G. E. McIntosh, Ottawa, Ont.; D. McKee, Toronto, Ont.; W. C. McKillican, Winnipeg, Man.; L. S. McLaine, Ottawa, Ont.; L. C. McOuat, Ottawa, Ont.; G. P. McRostie, Ottawa, Ont.; J. E. McRostie, Ottawa, Ont.; A. McTaggart, Macdonald College, P.Q.

H. M. Nagant, La Trappe, P.Q.; E. F. Neff, Athens, Ont.; A. R. Ness, Macdonald College, P.Q.; S. J. Neville, Ottawa, Ont.; L. H. Newman, Ottawa, Ont.; R. Newton, Edmonton, Alta.; F. C. Nunnick, Ottawa, Ont.

E. F. Palmer, Vineland Station, Ont.; G. S. Peart, Ottawa, Ont.; A. Pepin, Quebec, P.Q.; W. H. Perron, Montreal, P.Q.; C. E. Petch, Hemmingford, P.Q.; J. N. Ponton, Montreal, P.Q.

J. B. Reynolds, Guelph, Ont.; W. R. Reek, Ridgetown, Ont.; E. Rhoades, Ottawa, Ont.; P. O. Ripley, Lennoxville, P.Q.; T. F. Ritchie, Ont.; W. B. Roadhouse, Toronto, Ont.; G. Robertson, Ottawa, Ont.; F. E. M. Robinson, Richmond, P.Q.; G. B. Rothwell, Ottawa, Ont.; L. C. Roy, Cookshire, P.Q.; L. P. Roy, Quebec, P.Q.

F. N. Savoie, Quebec, P.Q.; C. E. Saunders, Ottawa, Ont.; J. Simard, Quebec, P.Q.; C. M. Slagg, Ottawa, Ont.; J. F. Snell, Macdonald College, P.Q.; J. B. Spencer, Ottawa, Ont.; J. A. Ste. Marie, Ste. Anne de la Pocatière, P.Q.; G. M. Stewart, Calgary, Alta.; P. Stewart, Ottawa, Ont.; H. G. L. Strange, Fenn, Alta.; J. M. Swaine, Ottawa, Ont.; C. Sweet, Ottawa, Ont.; R. Summerby, Macdonald College, P.Q.; W. Southworth, Winnipeg, Man.

W. J. Tawse, Macdonald College, P.Q.; A. G. Taylor, Ottawa, Ont.; R. Thomas, Montreal, P.Q.; C. Tice, Victoria, B.C.; S. E. Todd, Toronto, Ont.; H. L. Trueman, Kemptville, Ont.; M. P. Tullis, Regina, Sask.

T. C. Vanterpool, Macdonald College, P.Q.

R. W. Wade, Toronto, Ont.; F. T. Wahlen, Ottawa, Ont.; A. H. White, Ottawa, Ont.; O. C. White, Ottawa, Ont.; W. R. White, Ottawa, Ont.; A. G. O. Whiteside, Ottawa, Ont.; J. E. D. Whitmore, Ottawa, Ont.; W. T. G. Wiener, Winnipeg, Man.; G. R. Wilson, Moncton, N.B.; W. H. Wright, Toronto, Ont.

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* Copies of the original group photograph, reduced above, can be ordered through the General Secretary at $1.50, postage paid. The size is 27 by 9 inches. It is well worth framing as a permanent souvenir and record.

Report of the Committee on Graduate Studies.*

G. G. MOE, Chairman

University of British Columbia, Vancouver, B.C.

At the last annual Convention, the Committee on Graduate Studies presented a programme for your consideration and submitted a report on Section 1 of that programme. To-day it is the privilege of your Committee to report on Section II of the same programme.

This section reads as follows:

A study of three fundamental questions:

A. The relation between undergraduate and graduate courses with regard to division and sequence of work.

B. The nature and content of courses leading to the master's and doctor's degrees.

C. The general question as to what proportion of the graduate work might with advantage be taken in the natural science departments of our universities.

Before presenting the main material of this report perhaps you will permit me to outline the idea which the Committee has been following in its investigations, particularly in its application to the graduate work leading to a doctorate degree.

It is a well known fact that in many quarters there is a distinct reaction against the idea of heavy course work in graduate studies, such as is the practice in the large graduate schools of some American Universities. It is felt that instead of so much course work, the student should develop his own initiative and seek for himself the instruction now given in regular lectures. With this in mind and in consideration of the fact that when the graduate work takes the form mostly of course work, a heavy expense is involved in teaching staff, it seemed to the Committee a reasonable conclusion that a plan such as the following might offer a partial solution of the difficulties surrounding the giving of graduate work in Canada, particularly work of a doctorate grade.

The plan is this: That the student register in a certain University under the direction of the professor with whom he wished to work, and that as his work progressed, and his academic weaknesses were revealed, he then be advised to take such courses as might be required to correct his deficiences. These courses in all probability would be taken in pure science, and at such Universities as the Professor in charge might advise. As the student approached the completion of his work, and at the end of same, he would go up for examination before a Board composed of leading men in the line of work in which he was specializing and whose academic attainments stamped them as being qualified judges of the candidate's fitness to receive the doctorate degree. The foregoing idea differs little, if any, from that proposed by the Committee on Graduate Studies of the Universities' Conference.

The Committee is indebted, however, to President Suzzalo of the University of Washington for the suggestion that the student take only such course work as is required to round out his training. The plan, as a whole, emphasizes independent work under advisory direction, rather than heavy course work with little opportunity on the part of the student to develop the spirit of independent study and research. Taking into consideration also the fact that financial limitations, on the part of Canadian Universities, will limit for some time the amount of graduate work given in Canada and that the number of students who will wish to proceed to doctorate degrees will be low, the Committee permitted the thread of this idea to run through the accompanying questionnaire.

It has been the aim of the Committee wherever possible to secure official statements by the faculties of the various Universities in reply to the various points embodied in the questionnaire. The replies presented represent the consensus of opinion as expressed by the Universities.

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* Presented at the Sixth Annual Convention, C. S.T.A., Ottawa, Ont., June 24, 1926.

QUESTIONNAIRE PERTAINING TO PARAGRAPHS IIA, IIB AND IIC OF COMMITTEE PROGRAMME

11A. Undergraduate Courses.

1. In general do you believe that the courses offered in our agricultural colleges, and required for the bachelor's degree, meet the needs of the student who wishes to take graduate work, and fit him or herself for a technical position?

   The courses must be somewhat a compromise between needs of students who will and those who will not go on for graduate work.

2. Do you consider that the arrangement of the undergraduate courses should permit of a high degree of specialization in one of the agricultural subjects such as Animal Husbandry, Horticulture, Agronomy, etc., or do you consider that courses should be general in character, giving a fundamental training in the principles of agriculture as represented by the general courses offered in the different departments, rather than a specialized training in one particular field?

   A general course giving the fundamental sciences and a broad knowledge of technical agriculture.

3. Should the undergraduate, who contemplates engaging in technical work, concentrate on the agricultural phases of his course, or should he endeavour to lay a solid foundation in the sciences in order that he may be prepared to proceed with advanced work without having to spend time on preliminary science courses?

   The undergraduate who contemplates engaging in technical work should devote his undergraduate studies to the laying of a good foundation in the sciences, supplemented by general courses in the main branches of agriculture.

11B. Master's Courses.

1. In view of the fact that in the appointment of men to some of the minor and junior positions available in our technical departments, preference is now given to the applicant holding a master's degree, do you favour reducing the amount of specialized work in the agricultural subjects of our undergraduate courses, and the giving of this specialized work in the master courses, or do you favour a fairly high degree of undergraduate specialization in the agricultural subjects, thus permitting the student in his master's course to devote his time primarily to the basic and companion science subjects?

   In so far as is practicable, the sciences and the basic subjects should be given in the undergraduate course.

2. In the light of present day problems, do you consider that there is a place for purely agricultural subjects in the master courses, such as Advanced Farm Crops. Advanced Crop Judging, Advanced Pomology, Advanced Live Stock Judging, etc., or do you consider that the graduate course for the master's degree should be confined to work in the basic sciences, such as Biochemistry, Physical Chemistry, Bacteriology, Physiology, Genetics, Cytology, Biometry, etc.?

   Advanced farm crop judging or advanced live stock judging are not suitable problems for a master's course, unless there is some scientific problem involved.

3. Do you consider a foreign language an essential requirement of the master's course?

   A reading knowledge of English or French and another approved language.

4. Apart from the time devoted to research work on the thesis problem, do you believe in the expediency of extra-mural courses?

   To a limited extent to meet special cases.

5. In your opinion, where the work for the master's degree is performed extra-murally, can the technique involved in the research problems replace satisfactorily the training in experimental and laboratory methods given in regular courses taken in residence?

   Only in exceptional cases.

11B. Doctorate Courses.

1. What balance in your opinion should be maintained between thesis, directed research and course work in doctorate studies?

   For the doctor's degree the candidates should devote about two-thirds of their time to research. No distinction should be made between thesis work and direct research.

11C.

1. Where a student holds a B.S.A. or an M.S.A. degree, and thus presumably possesses a fundamental knowledge and understanding of the problems in agriculture, do you consider that such a student may, without suffering any disadvantage from the standpoint of future research in agricultural problems, take his doctorate work, in its entirety, in the pure sciences?

   So far as courses are concerned, the student would ordinarily suffer no loss from taking his doctorate work entirely in the pure sciences, but his research should be devoted to an agricultural problem.

2. As an alternative to the above would you favour the idea of students in agriculture, who wish to proceed to a doctorate degree, taking the necessary courses in the pure sciences, but doing their research under the direction of a professor in some department of a Faculty of Agriculture?

   It does not matter whether the professor who directs the student's research belongs to agriculture or some other Faculty, so long as he has a sympathetic appreciation of the problems in hand.

3. From the standpoint of the student's training, would you consider it necessary or advisable that the courses in the pure sciences be given by teachers who are engaged in active research on problems intimately associated with agriculture?

   It does not matter whether the courses are taken from teachers engaged in research on agriculture or on some other problem; but it is very important that these teachers should have the research attitude and be sympathetic towards agricultural problems.

I have taken the liberty of dealing at some length with the various points in order to show you that this has not been merely a superficial inquiry, but that the Committee has made a very earnest attempt to secure the opinions of the Universities on these fundamental and vital questions.

Mr. President and fellow members, I wish that it were possible to reflect in this report the generous spirit shown by all the Universities in their discussion of the foregoing questionnaire. So marked has been this attitude that the Committee feels that the time is opportune to take a step that will bring to a focus the activities of this Committee since its inception.

Sections III and IV of the programme still remain to be considered. The Committee does not presume to say that the subjects in hand have been exhaustively studied or that more information of value could not be obtained by another year of careful work. The Committee feels however that in view of the spirit shown by all Universities and Agricultural Departments interested in the development of graduate work in Canada, the time is now ripe for this Society to take a forward step. The Committee have always felt that a careful inquiry would reveal that we possess in Canada adequate facilities for the giving of graduate work, if some free-working arrangement could be devised which would permit of their utilization. In the plan outlined at the beginning of this report, the Committee feels that they have established the frame-work on which sound graduate work can be built. What is now needed is some one to assemble the material for the walls and the roof in order that the building may be completed. No attempt has been made to prepare a statement of the collective facilities available in Canada for graduate work. The Committee now proposes that this Society undertake the task of preparing such a statement, which would really be a graduate Calendar. Such a calendar should contain an official statement by each University of the courses of graduate grade available in that University, the library, laboratory and general research facilities, the lines of investigation being carried on by the various Departments, a statement of the regulations governing registration, and general requirements, fees, etc. The Calendar should also contain a statement respecting the facilities available for graduate work in our Dominion, and Provincial Departments of Agriculture. This Calendar would be placed in the hands of all members of the Society and graduating classes in Agriculture.

It is at once obvious that such a piece of work could not be performed by a general Committee. It would require the entire services of one man, who might be a special committee of one. It would be necessary that the person appointed should give his entire time to this task, for at least a period of six months. Respecting the question of remuner-

ation and expenses, the Committee suggests that the obstacles are not insuperable. We do not think that any one would question the need of such a Calendar, or the value of the work proposed. In the performance of this task the Committee feels that the Society has an opportunity to perform a piece of constructive work that alone would justify its organization. The above is submitted as a recommendation of the Committee on Graduate Studies.

The attention of the Committee has been directed to one other point, namely, part-time assistantships.

The value of part-time assistantships as an aid to graduate students is appreciated by all. Inasmuch as the research work performed by the students for the Institution is of great material assistance to the Department in which he is working, the Committee urges that the University endeavour to make available a larger number of part-time assistantships than now exist. This is submitted as a second recommendation from the Committee on Graduate Studies.

BOOK REVIEWS

INTRODUCTORY COLLEGE CHEMISTRY by Neil E. Gordon. (World Book Company, Yonkers-on-Hudson New York and Chicago, 1926, pp. xiv and 688 with 134 illustrations. $3.80.)

Two outstanding qualities characterize this admirable text-book.

The first is its modernity. The Table of Elements gives the number of isotypes as well as the atomic weights and includes not only Hafnium but also (necessarily without constants) the still more recently discovered Masurium, Rhenium and Illinium. The constitution of atoms is not only described but illustrated by diagrams and used in equation writing. A twenty page "book" is devoted to colloidal chemistry.

The second feature is the attention paid to pedagogical principles. (The author is editor of the world's first and only Journal of Chemical Education). "In accordance with the project and unit-study ideas, the material in this text-book is broken into definite short units and in as far as it has been possible to do so the material has been arranged so that the student can do his own work and his own thinking".

The text is divided into two parts; Nonmetals and metals. These are subdivided into, respectively, ten and eight "Books", which are further subdivided into from two to seven "Sections". Some of the Books are purely theoretical, others embrace either a periodic or an analytical family of elements. The Sections are chapters on individual elements, important compounds or classes of compounds or theoretical topics subsidiary to the general topic of the Book.

Further than the prominence given to the modern topics, referred to above, the selection of material does not differ materially from that in other current texts. It is in the manner of treatment that the book shows its individuality.

Experiments (only 179, including those in qualitative analysis), questions and unfinished equations are interspersed through the text and space left for the student's notes and answers.

The reviewer approves of the introduction of experiment directions in the text for the reasons that it saves the student expense and induces him to correlate laboratory and class room instruction. Whether it is advisable to encourage students to write in text-books, which may be passed on to succeeding classes or to relieve them to so great an extent of the labor of composition in note-writing is open to question, but those who prefer can, of course, have their classes use separate note-books or loose leaves. J.F.S.

QUALITATIVE ANALYSIS by William C. Cooper. (World Book Company, Yonkers-on-Hudson, N.Y., and Chicago, 1926. viii and 142 pp. $1.52.)

This book strikes the reviewer as very old-fashioned. The reagents are not made according to the molar or normal system, no mention is made of ions, and the methods used include very little that was not current forty years ago. To the reviewer it does not appear that the book lives up to its profession of giving "the reason for each step as fully as possible" nor that it has the advantage over current text-books on qualitative analysis claimed in the publishers' note opposite the preface. It is only fair to say that this judgment is based on a casual examination and the merits of a laboratory book cannot be adequately judged without actual use with students. The publishers' share of the work appears to be well done. J.F.S.

Report of Committee on Marketing Education.*

A. A. MacMillan, *Chairman*

Chief, Sheep and Swine Division, Dominion Live Stock Branch, Ottawa

Two previous reports submitted by this Committee dealt with the discussion of resident instruction on marketing by Agricultural Colleges. It is proposed in this report to analyze the whole field of marketing education as related to the production and marketing of Canadian farm products.

Governments have found it necessary to extend marketing education beyond the Colleges. We have in Canada an elaborate system of Federal and Provincial Government Departments engaged wholly or partly in purely educational work in the marketing of farm products. All these promotive agencies have much in common and the effectiveness of their services depends largely on a proper appreciation of Dominion and Provincial problems and active co-operation in developing the principle of efficient marketing, whether the problem to be solved is one for Provincial or Federal activity. The Federal Department of Agriculture operates educational sections in connection with live stock, dairying, fruit and vegetables, seeds, poultry and eggs. Most of the Provincial Departments of Agriculture operate Departments specially charged with educational work and such agents as the Agricultural Representatives and Agronomists give a good deal of their time to educational work. In some provinces Extension Departments are attached to the Agricultural Colleges or to the Administrative Offices of the Departments of Agriculture and are engaged largely in marketing educational work.

Not many years ago practically the whole of the products of the farm were marketed through individuals or firms not engaged in the work of farm production. As a consequence there was a sharp break between production and marketing. Several means to breach the gap have been instituted. About the year 1890 the Federal Department of Agriculture began to institute marketing services in connection with dairy products and in 1900 with live stock, seed grains, and fruit. These marketing services now perform two functions, the one being to gather and correlate statistical data and the other to use this data through publicity channels in marketing. As these services became more firmly established, the idea grew that the farmer should enter into the marketing of his products. This idea manifested itself in a very elementary way at first, but gradually the co-operative idea developed and as the desire for participation on the part of the farmer in the marketing of his products became more general, the Provincial Departments of Agriculture began to function by assisting in directing agricultural enterprize along the lines of co-operative organization. The Federal Department also extended its work in this direction, working with the provinces in many instances and in other cases actually taking a leading part. The result has been that the cooperative idea has become general and the cooperative type of organization has now been extended to include almost all kinds and classes of farm products.

Cooperative organizations capitalized the principle of quality marketing. This eventually led to the establishment of definite grading standards for many products which have been legalized by legislation passed by Federal or Provincial Governments. Marketing education as carried on by the Federal and Provincial Departments of Agriculture and by the cooperative organizations themselves has played a very important part in developing among farmers generally the acceptance of the principle of marketing their products on a quality basis with definite differentials in price as between grades. This principle has been accepted by the allied industries which have to do with the manufacture or processing of certain farm commodities. The wholesale and retail sections of our trade have also found it to be in keeping with sound business practice to offer farm produce for sale in such a way that the consumer is able to buy with a guarantee of assurance as to quality. Marketing education has therefore been extended to reach and influence the consumer as well as the producer.

* Presented at the Sixth Annual Convention of the C.S.T.A., Ottawa, Ont., June, 1926.

The volume of opinion which has been developed favorable to co-operative marketing and the sale of agricultural products on a quality basis has resulted in the passing of a number of Federal Acts governing the grading and sale of products such as dairy products, fruit, eggs, hogs and grains. Other products such as wool come under a voluntary Government grading policy which is widely accepted by both producers and buyers.

The business of marketing farm products is so specialized with regard to each product that the agencies connected with marketing have found it necessary, in many cases, to institute means of giving information to producers and in some cases to consumers with reference to products in relation to the marketing of that product. This information with relation to marketing now really constitutes an important branch of marketing education. The machinery of marketing is so extensive and the marketing organizations are so numerous that time or space will not permit of a definite analysis of each type of Government direction or each group of marketing agencies. In analyzing the field of marketing education, certain specific organizations will be used to illustrate the kind and extent of work which may be classified as marketing education enterprize or marketing educational propaganda.

Any one of the more or less commercial branches could be used to illustrate the type and extent of marketing education which is carried on by the Federal Department of Agriculture. Being more familiar with the organization and work of the Dominion Live Stock Branch, I will outline such of its marketing policies as may be considered to be educational in character.

The Markets Intelligence Division collects, tabulates and distributes daily, weekly, monthly and annually, records of sales; weekly, monthly and annual statistical reports and reviews covering the various classes and types of commercial livestock. The Stock Yards Service regulates and promotes the marketing facilities and agencies which have been provided for the proper merchandizing of our live stock surplus. This service has stimulated confidence in the centralized marketing system in vogue in this country and has done much to steady, equalize and stabilize live stock values. This illustrates the type of marketing education which facilitates marketing but does not have any direct connection with the movement or sale of the product.

Another type of marketing education and one which differs from the preceding in that a measure of control is exercised in influencing the quality of the marketable product, its movement to market and distribution, is the marketing service rendered by the promotion staff of the Sheep and Swine Division in the Maritime Provinces. This service has already resulted in the organization of local marketing units where the cooperative principle is the basic factor in handling carlot shipments of livestock for sale so that the producer receives settlement in accordance with quality and grade. The results obtaining from this type of educational service have brought about a very marked stimulation in production, a better distribution of product to the markets and a higher average price to the producer. In this work the promoter directs the organization policy. He is also recognized as the sales adviser. This service is continued only until such time as the local units have attained a sufficient practical knowledge of the marketing problems which confront them and by amalgamation are able to organize a central selling agency capable of employing an efficient sales manager.

An example of the final result in such a type of marketing education is the Canadian Cooperative Wool Growers Limited. This organization which is to-day recognized as being an outstanding example of a Dominion-wide cooperative marketing agency came into being largely as a result of similar marketing assistance when local and provincial wool growers associations were formed and were directed in the improvement, assembling, grading and sale of their wool to the point where the present organization which is operated and controlled by the growers was commercially feasible.

Marketing education of another type is exemplified by the development of a national policy in connection with our swine industry. This service necessitated the development of a wider and more general comprehension of our export trade and the domestic markets. In this case the genesis of the problem lay in the stimulation of the production of a standard and uniform type of hog known as select bacon. Educational propaganda was

directed to obtain the necessary incentive towards the right kind of production. The status of Canadian bacon was so low and competition was so keen that the packing industry agreed to establish and maintain the 10% premium for the select bacon grade. This agreement made possible the exactment of hog grading regulations under the Live Stock and Live Stock Products Act. The machinery for the marketing and sale of hogs already existed but it was necessary to bring about an adjustment of the selling practices so as to make it possible for the producer to obtain the premium for the superior type of hog and thereby capitalize from a production and improvement standpoint the educational value of the 10% premium. This was brought about by the appointment of a staff of hog graders who undertook the grading of all hogs offered for sale at stock yards and abattoirs. In addition the promotion staff and hog graders through educational propaganda in the form of hog grading demonstrations were able to effect a direct contact with the producer and local marketing agencies, thereby creating a volume of public opinion in favor of the bacon hog and the sale of hogs on a graded basis. The result has been that the bacon hog is now accepted as the national type and furthermore, Canadian bacon and pork products are now recognized as among the best on the world's markets.

This is an example of marketing education where official regulations have been immediately effective in transforming the whole industry so that production is being intelligently directed towards meeting the exacting requirements of the export markets.

We might cite other examples which have been equally effective for the Poultry, Dairy, Fruit and Grain industries.

In the Provincial Departments of Agriculture the agricultural representative, the extension staffs and the marketing branches have made their most effective contribution to marketing education, particularly in the early stages of development, by advising and assisting local clubs which had been organized in general or mixed farming sections for the purpose of handling the major products which were produced within such club areas. As a considerable proportion of the marketable surplus of the various products handled by these clubs was absorbed by a consumptive demand which existed within the province itself, educational endeavour was largely confined to the problems in marketing connected with local outlets.

As time went on these clubs having decided that they could render an equally effective service in the purchasing of commodities required by the farmer undertook to enter this field of activity. Provincial officials now found it necessary to study the problems of commodity purchase and merchandizing and advise regarding the extent to which this form of activity was commercially feasible for local clubs.

When these local clubs became generally distributed in certain of the provinces the volume of the various products and commodities handled necessitates action being taken to provide central warehousing accommodation and the appointment of a central manager. There have been many steps leading to the perfecting of these services in each province. Space will not permit us to follow the various provincial organizations through the various stages of development. At the present time the Co-opérative Fédérée, with headquarters at Montreal, Quebec, the United Farmers Co-operative Co. with headquarters at Toronto and the United Grain Growers, Ltd., with headquarters at Winnipeg, provide the necessary warehousing facilities. In addition these organizations are staffed to grade and merchandize all classes of farm products. They also render the necessary services in the purchasing of commodities required by the local clubs.

With this type of organization, where the autonomy of the local club or association is maintained and where the local officers are continually in contact with the central staff in a business way, the opportunities for obtaining results from marketing educational propaganda are most favorable. Provincial Departments and the central organizations themselves recognize this fact and endeavour to enlighten the farmer on his marketing problems through the medium of official publications, marketing courses, market newsletters, marketing lectures and practical grading demonstrations.

There are many other provincial marketing activities which apply to commodities where the marketable surplus is produced within specified areas. The milk producers associations, the bean, tobacco, turnip and potato

growers' associations are in this category. Marketing education in connection with the organization of producers for the merchandizing of these products has been of more recent development; in fact some of these organizations are barely beyond the initial stages of development. Each one of these products requires a special type of educational activity dependent upon the market outlet and its special requirements. With the growth of marketing organization and subsequent expansion of business to proportions where it reached millions of dollars annually the larger organizations and particularly the organizations responsible for the handling of the western wheat crop and other farm grains were faced with the problem of regulated marketing. Out of this has grown the adoption of the principle of pooling. The wheat pool of Western Canada represents the possibilities which may result in the practical application of the pooling principle to the merchandizing of farm products. At the present time probably the most highly organized educational marketing propaganda of any time is being conducted with a view to educating farmers to understand and accept the practice of pooling in the marketing of grains, live stock, dairy products, poultry, eggs and various other farm products. Coincident with the principle of pooling has grown up the idea of regulated marketing within dominions of the Empire and even between nations that are interested in the production and marketing of similar products. If this idea is to be carried to the point of fruition, producers will have to be educated along lines of international marketing.

Marketing organization and development has been so rapid that the farmers as a whole have not been able to grasp the full significance of the relationship of present day production to present day marketing. The point might also be raised as to whether the curriculums of our Agricultural Colleges have been completely modernized in keeping with recent organization developments. Agricultural graduates employed by Provincial and Federal Governments may also ask themselves the question as to whether scientific research and production activities are being undertaken with a proper realization of the marketing problems that confront them today.

Your Committee feels after reviewing the whole field of marketing education that three suggestions may be made for improvement in our present policy:—

1st. That at Agricultural Colleges the present marketing courses would be strengthened and given a more practical application if each year several special lectures were introduced, these to be given on special phases of cooperative marketing, or marketing in general, by men who are managing or are in some way definitely connected with the business of marketing farm products.

2nd. That the holding annually of a special course in marketing at which the lectures for the most part would be given by men actually engaged in the business of marketing should prove a valuable medium by which graduates could give closer study to the problems of marketing. Such courses should also foster greater cohesion between scientific research and production in relation to marketing.

3rd. That special marketing education should be undertaken where farmers are suffering a financial loss because of unorganized and unintelligent production due to isolation, limited production or the special type of farming which climatic conditions necessitate.

La Revue Agronomique Canadienne

RÉDACTEUR—H. M. NAGANT

Impressions de la Convention d'Ottawa

On trouvera dans cette revue un rapport circonstancié de la 6ème Convention de la C.S.T.A., qui, cette année, a tenu ses séances dans la capitale fédérale, du 23 au 26 juin, avec les comptes-rendus des conférences générales et des importants travaux présentés dans les diverses sections, et des résolutions et amendements aux constitutions adoptés par les assemblées plénières à la suite des propositions ou suggestions présentées par les divers comités permanents ou temporaires. Rappelons seulement qu'une résolution qui intéressera peut-être le plus généralement tous les membres, est celle qui ramène la cotisation annuelle, comme membre de la société, de six piastres à cinq.

Pour le reste, il serait donc superflu de revenir sur ces sujets dans les pages françaises de l'organe officiel de la C.S.T.A. Disons seulement que l'impression générale qui se dégage du dernier congrès est plus que jamais celle d'une véritable puissance organisée pour la solution des grands problèmes agricoles du Canada et les progrès de la profession. Jamais depuis l'existence de notre société, ces assises annuelles ne réunirent un nombre aussi considérable d'assistants, animés tous du plus parfait esprit d'entente et de coopération tendant vers le même but: faire progresser l'agriculture, industrie fondamentale du pays, par l'organisation technique.

A la façade du "Château Laurier", le splendide hôtel de Chemins de fer nationaux du Canada, une inscription en grandes lettres lumineuses souhaita la bienvenue aux membres de la C.S.T.A., depuis de soir du 22 juin jusqu'au matin du 26. On sentait bien que les agronomes, comme les autres grands corps professionnels, avaient acquis droit de cité dans la capitale fédérale où, pendant trois grandes journées, ils se coudoyèrent dans les grands halls et les élégants salons du Château Laurier, avec les membres de la députation si préoccupés en cette fin de session pleine de fièvre, créant nécessairement une vive impression et un réel mouvement de curiosité dans le grand public peu au courant encore des activités de l'agriculture technique.

Disons aussi combien fut appréciée, par tous les assistants de cette convention, la réception cordiale autant que généreuse que nous firent le Département fédéral de l'Agriculture d'Ottawa, si dignement représenté par ses sous-ministres, messieurs Grisdale et Charron, et le départment provincial d'Ontario, dont nous eumes le plaisir d'avoir parmi nous le ministre, l'honorable John S. Martin et son sous-ministre.

Non moins remarqués furent le dévouement et l'empressement dont firent preuve le bureau et les membres de section locale de l'Est d'Ontario, qui a son siège à Ottawa, pour la parfaite organisation de ce Congrès et pour l'obligeance témoignée vis-à-vis des autres membres, sans oublier notre excellent ami, monsieur Fred. Grindley, le secrétaire général, qui mérite une mention spéciale pour avoir été comme toujours la cheville ouvrière de toute l'organisation et l'homme qui a été à la tâche jour et nuit pendant toute la durée du congrès.

Ce qui aura frappé aussi, c'est le ton sérieux et le fond solide de tous les discours et discussions faits à l'occasion des banquets ou au cours des assemblées. Citons parmi ceux qui ont largement contribué à créer cette impression, le Dr. Grisdale, dont le discours sur les activités du Département fédéral de l'Agriculture, au banquet offert par ce département, le 23 juin, se déroula comme l'exposé d'un chef d'état major qui explique tout un plan de campagne longuement élaboré; le Dean E. A. Howes, du collège d'agriculture d'Edmonton, président sortant de la C.S.T.A.;

Cette photo prise devant le Parlemant d'Ottawa, représente le groupe des membres de la Province de Québec, ayant assisté à la sixième convention annuelle de la C.S.T.A. Il est formé de représentants des sections du Collège Macdonald, de Montréal, de Québec et de Ste. Anne de la Pocatiére auxquels se sont joint le nouveau Président, Docteur G. C. Creelman et le Secrétaire-Général, Fred. H. Grindley.

Rangée d' avant (de gauche à droite)—Geo. Bouchard, R. Père Leopold, J. E. Montreuil, G. C. Creelman, L. C. Roy, L. H. Hamilton, L. P. Roy, H. Barton, N. Savoie, F. H. Grindley.

Deuxième rangée—J. C. Magnan, F. E. M. Robinson, E. A. Lods, A. R. Ness, R. L. Conklin, H. M. Nagant, J. F. Snell, C. E. Petch, T. C. Bunting, J. A. Ste. Marie.

Rangée d' arrière—A. Pépin, B. T. Dickson, T. C. Vanterpool, Pascal Fortier, A. Gosselin, Jules Simard, W. W. Lee, W. J. Tawse, A. McTaggart.

le Dr. G. C. Creelman, ancien président du collège de Guelph et digne successeur du précédent, à la présidence de la C.S.T.A.; monsieur J. B. Reynolds, président actuel du collège d'agriculture d'Ontario; le Dr. L. S. Klinck, président de l'Université de la Colombie britannique, etc, qui tous surent intéresser profondément leurs auditoires par la manière originale et appropriée de traiter des problèmes généraux de l'agriculture du Canada ou des intérêts particuliers de notre association professionnelle.

Fort goûtées aussi furent la plupart des conférences données sous les auspices du Département fédéral de l'Agriculture, par différents spécialistes. N'ayant pu assister à toutes, nous nous bornerons à signaler surtout les trois causeries du Dr. Morrison, auteur de l'ouvrage bien connu, "Feeds and Feeding", sur des questions récentes en matière d'alimentation. Nous pensons que tous les auditeurs auront été d'accord pour reconnaitre qu'elles se distinguèrent par la clarté et le côté pratique.

Au lunch de la C.S.T.A., qui réunit pour la première fois à table les délégués à la convention, ce fut monsieur J. N. Ponton de Montréal qui apporta les salutations des sections de Québec.

Enfin, nous pouvons ajouter que la meilleure entente ne cessa de règner entre la délégation canadienne-française de la province de Québec, fort bien représentée, mais qu'on aurait aimé plus nombreuse encore, et leurs confrères de langue anglaise. Cette parfaite entente semblait d'ailleurs symbolisée par la présence à la table d'honneur du banquet offert par le Département fédéral de l'Agriculture, des deux sous-ministres, messieurs Grisdale et Charron. Elle se manifesta aussi par la demande expressse faite à votre serviteur de répondre en français au discours prononcé par le Dr. Grisdale, sur la profession, au dit banquet.

On voudra bien nous pardonner si nous reproduisons ici le texte de cette réponse en considérant que la seule importance que nous lui accordions est le témoignage de l'esprit de coopération qui doit exister dans notre association entre les éléments des deux races.

Réponse de H. M. Nagant, secrétaire français de la C.S.T.A., au discours du Dr. Grisdale, sous-ministre du Départment d'Agriculture d'Ottawa, présidant le banquet offert par le Département à la convention de la C.S.T.A., le 23 juin 1926.

Monsieur le Président, Messieurs,

"S'il y avait quelqu'un de qualifié pour s'adresser aux professionnels de la technique agricole, c'était certes le Dr. Grisdale, qui la représente de la façon la plus éminente dans le Dominion du Canada.

"Après des études au collèges de Guelph et de Ames, il s'est distingué à tous les échelons de la hiérarchie agronomique, acquérant une vaste expérience dans sa carrière si féconde comme directeur des Fermes Expérimentales du Dominion, qu'il sut porter à l'état de développement et d'efficacité que vous leur connaissez aujourd'hui, pour atteindre le faite de la profession en qualité de Sous-ministre de l'Agriculture de ce pays immense qu'est le Canada développant sa ceinture de terres cultivables, de l'Est à l'Ouest, sur une longueur de plus de 4000 milles, avec des conditions si diverses de climat, de sol, de moyens d'accès, de voies de transport et de marchés.

"Aussi je considère que c'est pour moi un grand honneur en même temps qu'un vif plaisir, d'avoir le privilège de remercier le Dr. Grisdale, au nom des membres Canadiens-français, des bonnes paroles qu'il a eues pour notre corps professionnel dont l'importance pourrait être difficilement exagérée. Ne représente-t-il pas, en effet, l'état major de la plus colossale armée que puisse posséder un pays, celle des exploitants du sol, source première de toute prospérité.

"A la différence des régiments levés par les haines, les rivalités, les convoitises des peuples, qui ne dépensent leur énergie qu'à semer la destruction pour récolter la ruine, l'armée pacifique des soldats du sol, animée d'une émulation bienfaisante, consacre toutes ses activités à édifier la vie et le bien être, à panser les plaies causées par les guerres sanglantes.

"Or, il y a eu peu d'époques, peut-être, dans l'histoire des nations, où cette nécessité de porter réparation aux maux cruels engendrés par une guerre dont l'humanité n'offre certainement pas d'autre exemple, se soit imposée d'avantage qu'à celle d'aujourdhui. Si le Canada qui, lui aussi, sortit du conflit mondial avec des charges financières vraiment écrasantes pour une jeune nation, montre, depuis

n an surtout, des signes de récupération re-
ıarquables, c'est avant tout à son agriculture
í vigoureuse qu'il le doit.

"Il est donc bon que pour continuer et com-
léter cette oeuvre de réparation, les membres
e l'état major des grandes armées du sol se
éunissent de temps en temps en une conven-
ion telle que celle qui vient d'être ouverte
ujourd'hui sous la direction des grands chefs,
t avec le concours d'experts spécialistes, ap-
elés pour cette occasion, afin d'étudier les
roblèmes majeurs de notre profession, de dis-
uter les plans de campagne qui assureront
e nouvelles victoires pacifiques à notre pays.

"Aussi en vous remerciant, monsieur le
ous-ministre, au nom des membres Canadiens
rançais de l'état major agronomique de ce
rand pays, je tiens à vous dire aussi com-
ien ils s'associent de tout coeur à leurs con-
rères de langue anglaise pour travailler en
ommun à l'honneur de leur profession, à
'avancement de l'agriculture du Canada.

"Dans ce pays dont l'avenir dépend de la
oopération de deux grandes races qui s'y cou-
oient depuis son origine, il a été souvent
uestion de bonne entente; on en a parlé dans
es journaux; des voyages ont été organisés
our faire rencontrer des gens de diverses pro-
essions des provinces de langue anglaise et
e langue française. Ceci a été très bien et
ıérite certes d'être encouragé, mais je crois
ouvoir dire que nous, Techniciens agricoles,
ous avons fait mieux encore; sans en parler,
ous avons réalisé cette bonne entente, et cela
'abord en fondant notre association com-
ıune, voilà déjà six ans de celà; en publiant
omme organe officiel de cette association une
evue bilingue, portant un double titre:
Scientific agriculture" et "Revue agrono-
ıique", fait unique dans son genre, je crois,
u Canada.

"Oui, nous le reconnaissons, cette participa-
ion française dans le mouvement scientifique
gricole a été modeste jusqu'ici.

"D'abord, il faut tenir compte que nous ne représentons que 25% de la population du Canada; ensuite la Province de Québec, plus traditionaliste, plus lente à adopter des directions nouvelles, s'est peut-être laissée devancer par sa province soeur, l'Ontario, dans la fondation d'un grand Collège d'Agriculture, tel que Guelph, qui depuis tant d'années fournit des gradués, maintenant dans la pleine maturité de leur carrière.

Sur son propre terrain, un mécène de langue anglaise, très heureusement inspiré, a cru qu'il ne pouvait faire un meilleur emploi de son immense fortune qu'en dotant ses compatriotes de la magnifique institution qui porte le nom de: "College Macdonald", pendant que les jeunes provinces de l'Ouest, brulant toutes les étapes et prenant comme modèle les Etats-Unis, édifièrent immédiatement les somptueuses Universités Agricoles que nous pouvons admirer à Winnipeg, Saskatoon et Edmonton.

"Mais la Province de Québec, plus lente à partir, s'est mise en marche aussi, ses collèges d'agriculture, hier encore si dépourvus d'outillage, commencent à s'équiper. Ceux qui ont visité dernièrement nos collèges d'agriculture de Ste. Anne de la Pocatière et d'Oka ont pu s'en convaincre. Les membres qui viennent de la convention de la "Seed growers association", tenue en cette dernière institution, notamment, auront constaté que nous y possédons aujourd'hui des laboratoires répondant aux besoins d'un enseignement agricole scientifique. Notre programme n'est pas encore terminé; il nous reste beaucoup de projets à réaliser; mais nous nous réjouissons, monsieur le Sous-ministre, de voir que, grâce aux progrès accomplis, la collaboration de langue française dans la grande association des Techniciens agricoles du Dominion, promet d'être plus large et plus efficace que dans le passé."

HONORE PAR DEUX PAYS.

L'Honorable J. Ed. Caron, lors de son pas-
age à Bruxelles, a reçu de sa majesté le Roi
lbert de Belgique les insignes de "*Command-
ur de l'Ordre de la Couronne de Belgique*".
ous apprenons aussi que le gouvernement de
ı République française vient de conférer le
tre "*d'officier de la Legion d'Honneur*", à
Honorable ministre de l'agriculture de la province de Québec.

Nous adressons nos respectueuses et très sincères félicitations à l'Honorable J Ed. Caron, pour ces flatteuses distinctions, si bien méritées au cours de sa longue et féconde carrière à la tête du Département de l'Agriculture de notre province.

Essais de Solubilite Sur le Beurre et ses Substituts.*

ALBERT LEDUC

Institut Agricole d'Oka

Les corps gras, groupe chimique important, bien que de composition analogue, sont assez difficiles à analyser.

Les corps gras sont souvent mélangés les uns avec les autres dans le commerce des graisses alimentaires, notamment dans celui du beurre.

Il arrive quelquefois que non seulement on mélange un ou des corps gras à celui en vente mais que l'on fasse même une substitution complète. Ainsi certaines "huiles vierges de Nice" ont été reconnues autrefois entièrement "vierges" d'huile d'olive.

Du suif, de la graisse d'oie, de l'huile de pied de cheval pourraient donc nous être vendus pour du beurre, la chimie industrielle en fait tant de nos jours?

C'est possible. Mais la chimie a sa police chargée de surveiller ce beau champ de fraudes. Elle emploie de nombreux moyens physiques et chimiques, délicats et requérant toute son attention, il est vrai, pour trouver les adultérations, déjouer les nombreux pièges qui lui sont tendus par les industriels et les commerçants éhontés qui veulent s'enrichir au plus vite,—*auri sacra fames*—,souvent au détriment de la santé des consommateurs.

La loi a fixé un standard. Le beurre, la matière butyreuse du lait, ne doit pas contenir plus de 16% d'eau; il doit avoir une densité d'au moins 0.905, à 40°C/40°C, un indice Reichert-Meissl (nombre de c.c. d'alcali O.1N requis pour saturer les acides gras volatils *solubles* obtenus par la distillation de 5 g. du corps gras à analyser) d'au moins 24 et pas plus du dixième de ce dernier comme indice Polenske (nombre de c.c. d'alcali O.1N requis pour saturer les acides gras volatils *insolubles* obtenus par la distillation de 5 g. du corps gras).

Ces nombres ou indices semblent actuellement les meilleurs pour découvrir les adultérations du beurre, mais ils requièrent beaucoup de soin et un assez long temps et ils ne permettent pas de se prononcer dans le cas de l'addition de certains gras dans la proportion de 5 à 10% seulement.

Aussi un grand nombre de méthodes furent-elles expérimentées et présentées pour venir en aide aux chimistes analystes.

Ce travail-ci comprend un court résumé de la documentation volumineuse sur les essais faits pour l'amélioration d'une méthode physique applicable à l'analyse du beurre et de ses adultérants les plus communs et un compte-rendu d'un travail personnel en vue d'obtenir une nouvelle méthode plus rapide et capable de découvrir de plus faibles adultérations.

La méthode physique en question est basée sur la solubilité des corps gras dans certains dissolvants, v.g. éther de pétrole, éther éthylique, benzine, alcool absolu, acide acétique glacial, etc.

C'est un fait bien connu que les solutions chaudes et limpides de corps gras dans certains dissolvants deviennent troubles en se refroidissant. On observe encore ce phénomène dans la solution d'un corps gras quand un dissolvant moins bon que le dissolvant qui a servi à la dissolution lui est ajouté, ce dissolvant étant naturellement moins bon ou rendu tel par l'addition d'une substance étrangère, comme l'eau. La température à laquelle le trouble se produit ou le nombre de centimètres cubes de précipitant requis pour obtenir un trouble sont appelés "point trouble", dans le premier cas et "nombre trouble", dans le second. La recherche des "points et nombres troubles" des différents corps gras peut s'appeler "essais troubles" ou essais de solubilité.

Les huiles de coton, d'arachide, de sésame, la graisse de coco, de porc, le suif, l'oléo oil (huile extraite des suifs de boeuf, de veau et de mouton bien frais) et l'oléomargarine sont des adultérants fréquents du beurre. La graisse de coco est, au Canada, le substitut le plus commun. Parmi les autres, ceux que l'on rencontre surtout en Amérique sont l'huile de coton et l'oléomargarine.

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* Cet article est un bref résumé de la thèse présentée par monsieur Leduc pour l'obtention du degré de M. Sc. à l'Université McGill, de Montréal.

Ajoutons pour compléter la liste que l'on peut encore employer assez bien à la falsification du beurre, parmi les graisses animales, les graisses de cheval, de mouton, d'oie, plus difficilement celles d'anesse, de buffle, de chameau, d'autruche ou de canard, les huiles de pied de mouton, de cheval, etc. et, parmi les graisses végétales, les huiles de palme, de soleil, d'olive, de maïs, de noix, de noisette, de bassia, de colza, la graisse de dika, etc.

Examen et critique des essais de solubilité.

Indice de Crismer et indice acétique. — L'indice de Crismer et l'indice acétique sont les deux essais de solubilité les mieux réussis.

Dans la méthode Crismer (1) on met 0.5 c.c. du corps gras à analyser dans un tube à essai avec deux fois son volume d'alcool éthylique à 99.1%. Le mélange chauffé tant qu'il n'est pas devenu limpide est mis à refroidir jusqu'à l'obtention d'un précipité. On nomme température critique ou indice Crismer la température à laquelle le trouble apparaît.

Voici comment on trouve l'indice acétique (2) : mettre dans un tube à essai 3 c.c. de graisse, puis 3 c.c. d'acide acétique, D=1.0562; chauffer le tube jusqu'à clarification de la solution et laisser refroidir. L'indice acétique c'est la température à laquelle un trouble se produit.

Malheureusement, sans la détermination des acides volatils et de l'indice de réfraction, ces deux méthodes ne suffisent pas à découvrir n'importe quel mélange de graisse de coco et de graisse animale, parce qu'un mélange bien fait de ces deux graisses a une constante de 55 à 56, tout comme le beurre. De plus, les réactifs dans ces deux méthodes (alcool et acide acétique) ont besoin de réajustements assez fréquents, à cause de leur hygroscopicité prononcée.

Plusieurs investigateurs essayèrent de substituer d'autres méthodes de solubilité aux deux précédentes. P. Bockairy (3) se servit de toluène et d'alcool à 96.7%; H. Dupertuis (4), d'un mélange d'un volume d'aniline et de quatre volumes d'alcool; Seidenberg (5), d'un mélange d'éther et d'alcool à 98.5%; Sheffer 6), d'alcool amylique et d'éther; Parkes (7), d'un mélange d'acide acétique avec ses homologues plus élevés dans la série, acide propionique, butyrique ou valérianique; Jean (8), d'acide acétique, D=1.0565; Crooks (9), d'acide phénique liquide; Louise et Sauvage (10), d'acétone; Fryer et Weston (11), d'alcool éthylique et amylique; Dubois et Padé (12), de benzine.

Aucune de ces méthodes, cependant, ne fut beaucoup employée dans la recherche des adultérations du beurre. Il semble que c'est parce que leurs auteurs ne les travaillèrent pas à fond. Quelques-unes peuvent, pourtant, servir à l'identification des huiles et des graisses pures et à appuyer les résultats fournis par d'autres méthodes.

Nouvelle expérience

J'ai limité mon travail de recherche au beurre et à ses adultérants les plus probables, notamment à la graisse de coco. Au lieu de déterminer la température critique, j'ai mesuré la quantité de précipitant (acétone) requise pour obtenir un trouble dans une solution limpide de corps gras (solution dans de l'alcool butylique normal), à une température définie.

Méthode.—Mettre 5 c.c. de corps gras dans un gros tube à essai d'une capacité de 130 c.c.; ajouter 10 c.c. d'alcool butrylique normal et mettre le tube dans un vase d'eau à 45°. Tenir un thermomètre dans le tube que l'on doit agiter une couple de fois et, quand la température de la solution a atteint 45°, prendre le "nombre trouble" en laissant couler dans la solution le réactif contenu dans une burette à la température ambiante. La température de la solution doit être à 45° afin que 5 c.c. de gras de beurre puissent se dissoudre dans 10 c.c. d'alcool butylique. Le trouble, léger d'abord, devient bien marqué après l'addition de quelques gouttes de réactif de plus; 0.5 c.c. de réactif de plus rend le trouble très prononcé et 0.5 c.c. de réactif en plus ou en moins n'affecte presque pas la sensibilité de la méthode. Dans le cas de gras de beurre nous devons réajuster la température à 26°, après l'addition de 40 c.c. de réactif, parce que la température du réactif varie de 20 à 30° suivant la température extérieure et peut affecter sérieusement les résultats.

Dissolvant et précipitant employés.

L'alcool butylique normal et l'acétone employés sont les produits commerciaux de la Eastman Kodak Co., et ils ne coûtent pas cher. On ajoute à l'acétone (le précipitant) assez d'eau pour obtenir un "nombre trouble" de 22.4 avec l'huile d'amande, c'est-à dire environ 5% (l'huile d'amande sert de standard dans cette méthode). Une trop grande addition d'eau rendrait trop semblables les "nombres troubles" des divers corps, tandis

qu' une trop petite addition obligerait à un usage encombrant de précipitant.

Quantités relatives de corps gras et de dissolvant.

Si l'on adopte une manière de procéder uniforme, il n'est pas nécessaire d'apporter un soin très minutieux au mesurage du corps gras et du dissolvant.

Stabilité du dissolvant et du précipitant.

L'alcool éthylique dans la méthode Crismer et l'acide acétique dans la méthode acétique ou de Valenta sont peu stables, nous l'avons déjà fait remarquer.

Par contre, l'alcool butylique normal et l'acétone ne s'altèrent pas si on les conserve dans des flacons.

Ainsi quand l'alcool butylique à mon usage donnait un "nombre trouble" de 23.4 avec de l'huile d'amande il donna un "nombre trouble" de 23.3 après une nuit laissé dans un flacon débouché.

Avec l'acétone j'obtins 22.5 et 22.4 après l'avoir laissée dans un flacon débouché durant 6 heures et 24 heures, quand j'avair dbtenu 21.3 et 22.8 auparavant.

Eau et température.

Il faut faire attention à l'humidité, à l'eau qui pourrait être introduite dans la solution. Les récipients doivent être bien secs parce que l'acétone contient un pourcentage d'eau défini et que toute autre eau ferait varier les résultats.

La température de la solution doit être portée à 45° avant d'y ajouter le précipitant et ajusté à 26° après l'addition de 40 c.c. de précipitant dans le cas de gras de beurre, parce qu'une aussi forte addition de réactif peut causer une variation de température dans différents essais et conséquemment une variation dans les "nombres troubles".

Expériences sur le beurre et ses substituts.

Il fallait qu'il y eut une bonne différence entre les "nombres troubles" du gras de beurre et de ses substituts et très peu de variation entre ceux de différents échantillons d'un même corps gras.

Prenant la moyenne de nombreux essais (nombreux pour quelques corps gras du moins, j'obtins les "nombres troubles" indiqués au tableau I, "nombres troubles" assez différents les uns des autres. (Les chiffres après le nom du corps gras indiquent le nombre d'essais fait sur le gras en question).

TABLEAU I.

"Nombres troubles" de différents corps gras.

Corps gras	"NOMBRE TROUBLE" Maximum	Minimum	Moyenne
Graisse de coco.	Pas de trouble.		
Gras de beurre, 32 essais.	50.9	44.3	48.5
Huile de coton, 22 "	34.5	33.0	33.5
Huile de sésame, 4 "	27.0	25.5	26.2
Huile d'amande, (standard).	22.4	22.4	22.4
Huile d'arachide, 2 essais.	20.5	20.3	20.4
Graisse de porc, 2 "	19.2	17.8	18.5
Oleo oil, 1 "	16.8	16.8	16.8
Suif de boeuf, 1 "	15.7	15.7	15.7
Oleomargarine animale, 3 essais	22.1	20.9	21.5
Oleomargarine végétale, 3 essais. Pas de trouble.			

Notons que ces essais furent faits sur un seul échantillon, à différentes dates, excepté pour le beurre qui provenait de même troupeau, mais de barattages différents.

Comme le "nombre trouble" du gras de beurre est le plus élevé il n'est pas surprenant de constater qu'il est aussi celui qui a le plus varié. Les autres corps gras donnèrent pratiquement le même "nombre trouble" dans tous les essais, même dans les tout premiers.

Le tableau II fait connaître les résultats obtenus avec des mélanges de gras de beurre et de graisse de coco. Dans ces expériences, au lieu d'employer l'huile d'amande pour ajuster la proportion d'eau de l'acétone je me suis servi de l'huile de coton dont il est question dans le tableau I.

Une addition de 20% de graisse de coco au beurre a un effet tel qu'il ne se produit

TABLEAU II.

"Nombres troubles" de mélanges de beurre et de graisse de coco.

Mélange.	"NOMBRE TROUBLE" 1er, essai.	2 ème essai. (1 semaine plus tard.)
Huile de coton (comme standard)	33.1	33.5
Beurre, pur.	47.2	50.0
Beurre avec 5% de graisse de coco.	48.7	53.6
Beurre avec 10% de graisse de coco.	52.5	66.8
Beurre avec 15% de graisse de coco.	62.1	70.0
Beurre avec 20% de graisse de coco.	100.0	70.0

pas de trouble dans la solution de ce mélange et qu'elle est, par conséquent, facile à reconnaître. 20% de graisse de coco n'affecte les indices de Crismer et acétique que de 4.8 et 9.0 respectivement, suivant Hoton. On se rend aussi facilement compte d'une addition de 15% de graisse de coco au beurre. Mais on ne peut se prononcer sûrement dans le cas d'une addition de 10%, à cause des variations dans les "nombres troubles" du beurre pur.

Expériences sur des beurres de vaches de races différentes.

Afin de me rendre compte s'il existe une variation considérable dans les nombres troubles du beurre pur et frais, je fis des essais sur du beurre provenant de gros troupeaux de différentes races de vaches.

Voici d'où provenaient ces beurres: Shorthorn, Alexandre Maclaren, Buckingham, Québec; Holstein, Donat Raymond, Vaudreuil, Québec; Canadienne, Pères Trappistes, La Trappe, Québec; Guernsey, C. E. Byers, Hawkesbury, Ont.; Jersey, F. G. Gale, Waterville, Québec; et Ayrshire, W. W. Skinner, Senneville, Québec.

Le tableau III donne les "nombres troubles" obtenus avec ces beurres en même temps que d'autres constantes.

La marge de variation n'est pas plus grande que celle obtenue durant mes expériences avec du beurre de l'Institut, beurre provenant d'un troupeau de vaches Ayrshires, Canadiennes et Holsteins. On peut donc conclure que l'essai est applicable au beurre de n'importe quelle race.

Si un manque de temps n'a pas permis de me rendre compte de toute l'efficacité de la méthode présente pour découvrir de faibles adultérations, je crois bien qu'elle peut servir à reconnaître sûrement les additions de 20 et de 15% de graisse de coco et qu'entre les mains d'un habitué elle indiquera assez bien une addition de 10%.

Je suggérerais à celui qui voudrait faire l'essai de la méthode ou qui voudrait l'améliorer en collaboration: (1) l'usage d'instruments propres et bien secs, (2) de faire l'essai avec les huiles d'amande, de sésame ou d'arachide, parce que de manipulations plus faciles que les graisses solides et moins variables dans leurs "nombres troubles", (3)

TABLEAU III.

"Nombres troubles" et autres constantes du beurre de troupeaux de différentes races.

	Acides gras libres, re oléique	Indice de saponification Koettstorfer	Indice Reichert-Meissl.	Indice Polenski.	Indice de réfraction	"Nombre trouble" 1er essai.	2 ème essai.
Ayrshire	0.52	223.8	31.2	3.0	1.44959	50.3	48.4
Canadienne	0.38	224.6	39.7	2.8	1.44959	44.3	48.4
Guernsey	0.49	226.5	27.8	2.1	1.44945	45.8	45.2
Holstein	0.37	221.0	30.4	2.8	1.44973	49.2	48.0
Jersey	0.35	225.7	29.7	2.8	1.44973	49.7	48.6
Shorthorn	0.52	228.0	27.3	1.8	1.44045	49.5	48.7
Huile d'amande	0.46	—	—	—	1.471478	22.6	22.4

d'attacher assez d'importance à la température de la solution.

CONCLUSION

1. La méthode présente permet de constater la présence dans le beurre de 20 et de 15% de graisse de coco mais n'est pas encore assez à point pour permettre de se prononcer dans le cas de faibles adultérations.

2. Dans cette méthode on mesure la quantité de précipitant (acétone commercial) requise pour qu'une solution de corps gras dans de l'alcool butylique normal devienne trouble à une température initiale de 45°.

3. La stabilité du dissolvant et du précipitant est remarquablement bonne.

4. La rapidité de l'essai peut épargner assez de temps à l'analyste dans le cas d'adultération considérable et donner de bonnes indications si la substitution est faible.

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J. CH. CHAPAIS

Au moment de mettre sous presse, nous apprenons le décès de monsieur J. Ch. Chapais qui fut, avec monsieur Marsan, parmi les premiers pionniers de la science agricole dans la province de Québec. Jeune encore, il abandonna le domaine du droit pour les problêmes de l'agriculture, et cela à une époque où pareil échange pouvait paraître un coup de tête peu digne d'un homme sérieux. Aussi peut-on dire que monsieur Chapais fut un véritable précurseur dans les sciences agronomiques; travailleur infatigable, levé dès les premières heures du jour, il fouillait laborieusement quantité de revues et de volumes agricoles. Il acquit une condition considérable dont il fit part dans les nombreux articles qu'il publia comme rédacteur et collaborateur du Journal d'Agriculture.

C'est avec émotion que nous rendons hommage à cet homme dont la vie empreinte d'une si haute dignité fut entièrement consacrée aux intérêts de la classe agricole.

Concerning the C.S.T.A.

This issue completes Volume VI of the ociety's official organ. For the convenience f those who intend to bind the magazine for eference purposes, a loose title page is en-losed and a subject and author index for the ntire volume is printed on pages 447 and 448. The present volume contains 56 pages more han Volume V.

Commencing with the next issue, a better uality of paper will be used in the magazine, o that illustrations may be printed more learly. The new paper will be of the same uality as that used in the printing of the *oronto Saturday Night.* Members will notice decided improvement in the appearance of he magazine.

The lectures given by Dr. F. B. Morrison nd Dr. T. U. H. Ellinger at the recent .S.T.A. Convention will be published in the ext issue, and those by Dr. C. L. Metcalf,)r. D. F. Jones and Dr. William Crocker will ollow as soon as possible.

Now that the Society is operating on an an-ual fee of $5.00, it is essential that members ay this fee promptly, either to the General ecretary or to their local secretary. There re other ways in which members can give ery definite assistance to the Society, among hich a few of the most important are here iven:—

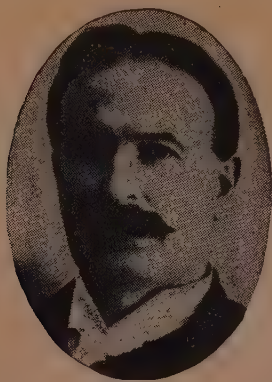
1. Contribute artcles to the magazine. We ant our members to publish their papers in heir own official organ. We can handle anuscripts promptly, and will furnish a easonable number of reprints free if good se can be made of them. No manuscript is o long or too short to be given fair con-ideration by the Editoral Board. The maga-ine is received by libraries and abstracting ournals throughout the world, and our Canadian workers should be giving it more support.

2. Remember that the C.S.T.A. and the magazine, are dependent upon advertsing revenue for their existence. Membership fees alone would not maintain the Society, in its present form, even if it published no magazine at all. If you can suggest to the General Secretary the names of any reliable commercial firms which, in your opinion, ought to be represented in our advertising pages, please do so. Write to the firms at the same time, and tell them something about the Society. Many of our members have official contacts with commercial houses and could give material assistance by recommending *Scientific Agriculture* as an advertising medium. Real co-operation of this kind would soon develop our advertising pages into a most useful guide to agricultural products and equipment.

3. During the month of September, a Dominion-wide membership campaign will be organized. It is extremely difficult to maintain an accurate record of the addresses of all agricultural graduates who are not yet members of the Society. Members can assist greatly by sending to the General Secretary the names and addresses of non-member graduates in their districts. Do this during the month of August. We want to put our membership past the 1,000 mark before Christmas.

4. Notify the General Secretary promptly of any change in your position or address. It is an easy thing to do and is usually of interest to your fellow-members.

5. If you have not yet filled out and returned to the General Secretary the blue card for the Bureau of Records, please do so now. It will save a lot of bother at the central office and will facilitate the maintenance of an accurate record of every member. No member should have any objection to furnishing the information asked for.



DR. F. C. HARRISON RESIGNS

Dr. F. C. Harrison (B.S.A., Toronto, 1892; D.Sc. McGill), has recently tendered his resignation to the Board of Governors of McGill University as Principal of Macdonald College and will devote his entire time to scientific research and the training of graduate students.

Dr. Harrison has been Professor of Bateriology at Macdonald College since 1907, Principal of the College since 1910 and Dean of the Faculty of Agriculture of McGill University from 1910 until 1925. The heavy responsibilities of his many duties, have affected his health, and he has expressed a wish to be relieved of administrative work. It is expected that he will move from Macdonald College to McGill University in the fall of this year. He was Professor of Bacteriology at the Ontario Agricultural College from 1896 until 1905, when he went to Ste. Anne de Bellevue to assist Dr. James W. Robertson in the planning, building and equipment of Macdonald College.

Dr. Harrison has long had a world-wide reputation as a bacteriologist and has written and published nuemrous papers on this subject. He was President of the Society of American Bacteriologists in 1921, and is a Fellow of the Royal Society of Canada.

Technical agriculturists in all parts of Canada will wish Dr. Harrison many more years of useful service in the field of research.

OTTAWA CONVENTION NOTES

The annual fee was reduced from $6.00 to $5.00 per year, applicable to all fees due on June 1st, 1926.

New regular members joining the C.S.T.A. will be required to pay an initiation fee of $5.00 in addition to the annual fee, except (a) graduates who join within 12 months after graduation, (b) members of the Western Canadian Society of Agronomy and the Western Canada Society of Animal Production (affiliated with C.S.T.A.) who join before June, 1927, and (c) former members of the C.S.T.A. who apply for membership before December 31st, 1926. These three classes are not required to pay the initiation fee.

There are a few copies of the *Morning Muddler* still available in the office of the General Secretary and will be sent free to members on request, as long as the supply lasts. Copies of the Annual Financial Statement for the year ending May 31st, 1926, are also available.

The Alberta members were afforded an opportunity to hear echoes of the Ottawa Convention at meetings in Calgary on July 7th and Edmonton on July 14th, when Major H. G. L. Strange and Dean E. A. Howes, respectively, gave a general report of the meetings.

In the front row of the group photograph on pages 426 and 427 of this issue, will be noticed four of the lecturers who attended the Convention: Dr. Morrison, Dr. Ellinger, Dr. Crocker and Dr. Metcalf. The Minister of Agriculture for Ontario, Hon. John S. Martin, is also in the front row. He gave a splendid address at the luncheon on June 24th.

MARRIAGES

We learn that Pat Stewart (O.A.C. '14), Secretary of the Canadian Seed Growers' Association, Gordon Crawford (O.A.C. '15) of the Dominion Entomological Branch, and L. P. Roy (Montreal '14) of the Quebec Dept. of Agriculture and Vice-President of the C.S.T.A., are to be married in August or September. A. C. McCulloch (O.A.C. '11), Dominion Poultry Promoter for Manitoba, was married in Winnipeg on June 30th.

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SEED BRANCH

Incidental with the increased acreages of estern Rye Grass and Awnless Brome Grass the Prairie Provinces, particularly in Mani-ba, the spread of Couch Grass, or Quack rass, has assumed alarming proportions. ommercial lots of Western Rye Grass and rome Grass seed infested with the seeds of ouch Grass were to a large extent responsible r this spread. The distinction of Couch rass seed from the seeds of Western Rye rass and many other species of the genus gropyron occurring in the West offers very usual difficulties and was held to be al-ost an impossibility in practical seed analy-s up to a short time ago. In view of the eat economic importance of the problem newed efforts were made by the Seed Branch overcome these difficulties with the result at last winter all samples of Western Rye rass and Brome Grass received in the Seed ranch laboratories could be examined for e presence of Couch Grass, thus making it ossible for the farmer to buy lots free of the eds of this objectionable weed. Mr. F. E. oulds, the Supervising Analyst in Winnipeg, whose laboratory more samples of Brome rass and Western Rye Grass are received an in any other, has spent a few weeks this mmer at the National Herbarium in Ottawa id at the Forage Crop Division of the Cen-al Experimental Farm studying the morpho-gical seed characters of a wide range of gropyron species with a view to placing this ork on a practicable basis for routine seed ialysis. Very marked progress has been ade in this work and it is hoped that this ill be an important step in the eradication Couch Grass in the affected areas of the est.

EXPERIMENTAL FARMS BRANCH

Poultry Division

Dr. Alwin Pappenheimer, Pathologist of e College of Physicians and Surgeons of Columbia University, internationally known as one of the greatest authorities on paraly-sis of man and animals, has consented to pre-sent a paper at the World's Poultry Congress to be held in Ottawa July 27 to August 4, 1927. Other famous scientists in attendance and presenting papers will be Dr. E. E. Tyzzer, of the Department of Comparative Pathology, Harvard Medical School, an auth-ority on protozoan diseases; Dr. B. F. Kaupp of the State College, North Carolina, Amer-ica's pioneer avian pathologist; Dr. B. J. C. te Hennepe Jzn, of the State Serum Labora-tories Rotterdam, Holland, a famous Euro-pean authority on fowl diseases; and Dr. Crow of Edinburgh University, an authority on breeding.

A marked improvement is shown in the size of egg being recorded in the 1926 egg-laying contests. At this season a year ago nearly three times as many eggs were being disre-garded as undersized. It is safe to say that the improvement is due to selection of pullets from large egg strains.

Cod-liver oil has again been used in experi-ments, and former findings confirmed. In one test 15 chickens all practically off their legs, treated with cod-liver oil, showed a marked improvement in three days, and were normal within 10 days.

Division of Illustration Stations

The Division has increased the number of its stations this spring, having started work at ten new points, namely, Cessford, Alta.; Gil-bert Plains and Eriksdale, Man.; Russell, Ont.; St. Alexandre, Black Lake, and Lac Megantic, Que.; Jacquet River and Apohaqui, N.B.; and South Brookfield, N.S.

Lime and Alfalfa Growing Demonstrations

In order to introduce and popularize the growing of alfalfa, where conditions are deemed suitable, demonstrations are under way on sixty-five Illustration Stations in Eastern Canada, comparing the standard grass and clover mixture made up of 8 pounds red clover, 2 pounds alsike and 10 pounds timothy, with a mixture containing alfalfa in the proportion of 5 pounds alfalfa, 5 pounds red clover, 2 pounds alsike and 10 pounds timothy. Parts of these fields have been limed, so that we may determine and demonstrate its effect on the establishment and permanancy of the alfalfa stand.

Illustration Stations as Seed Centres

During the past year, the Illustration Stations have functioned as seed centres in that the sales made by the operators amounted to 28,646 bushels of seed grain, 3,504 bushels of seed potatoes, and 7,606 pounds of grass and clover seed.

Division of Botany

The following promotion and additions to the staff have been made recently:

Dr. G. H. Berkeley, Officer-in-charge of the Dominion Field Laboratory of Plant Pathology at St. Catharines, Ont., promoted from Plant Pathologist to Senior Plant Pathologist.

Mr. G. C. Chamberlain, Assistant Plant Pathologist at the St. Catharines Laboratory.

Mr. K. A. Harrison, Assistant Plant Pathologist at the Kentville, N.S., Laboratory.

Mr. G. E. Woolliams, Assistant Plant Pathologist at the Summerland, B.C., Laboratory.

The new building for the Dominion Rust Research Laboratory at Winnipeg, Man., was completed early this year. The staff which is engaged in the study of the rust and smut diseases of grain crops are now adequately supplied with facilities for their work.

Chemistry Division

Soft Pork

The export bacon trade is one of great im portance to Canada; last year we receive from Great Britain $22,034,323 for this com modity alone. Further, there is every indica tion that the demand in England for first clas Canadian bacon has not yet reached its limit

Among the qualities necessary for first class bacon in England, none is of greater im portance than firmness. A tendency to soft ness or tenderness is quite sufficient to rat the bacon at second-class prices, and, if thi softness is at all pronounced, to make it al together unsaleable at a profit.

In 1901 and 1902 the Division of Chemistr of the Experimental Farms conducted an in vestigation into the character and causes o soft pork. The conclusions arrived at at tha time may be briefly summarized. By far th most significant factor in the production o soft pork *is the nature of the food.* Of all th grain ration employed, equal parts of oats peas and barley gave the finest pork. Whe corn formed any considerable part of the ra tion, the resulting pork showed a tendenc to softness. If corn was fed in conjunctio with skim milk it was shown that a consider able proportion of corn might be used with out injuring the quality of the pork. Th feeding of skim milk tends to thriftiness an rapid growth and counteracted in a ver marked manner any tendency to softness.

Since the time this work was carried o there have been great changes in pig raisin and feeding practices. Of late years a ver considerable proportion of the hogs reachin the packing houses have been raised in A berta under distinctly different conditions tha prevailed in Ontario in 1901. The object o the investigations recently instituted by th Division of Chemistry and Animal Husband in conjunction with the Canadian Meat Pacl ers' Association is to determine the effec that the present methods of feeding, especia ly in the Western provinces, may have on t quality of the pork in relation to its manufa ture into bacon.